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CONTENTS

In This Issue 5
Editorial: New Appointment Will Strengthen WPB Set-Up 105
Aviation's War Communique No. 16 106
Flight Testing Is a Sound Business ..... *Edmund T. Allen* 108
Aviation's Place in the Controlled Materials Plan ..... *John Foster, Jr.* 114
Absenteeism—What's the Problem? 116

Aviation Manufacturing

Production — Design — Research — Engineering, Complete Index 121
Consolidated Celebrates its 20th Anniversary 122
Single Assembly Line Produces Both Bombers and Transports, *R. C. Sebold and S. J. Powell* 126
Modification Centers—An American Military Innovation ..... *Glenn Hotchkiss* 134
Points On Plastics in Aircraft Engineering, I ..... *John Sasso* 141
Aircraft Tool Planning, I ..... *Richard H. Luders* 144
Airflow Visualization Opens New Avenues of Research ..... *Erwin J. Saxl* 148
Photoprint Process of Loft Layout Reproduction ..... *Frank B. Marshall* 154
Design Considerations for Plywood Structures, IV ..... *L. J. Marhoefer* 164
Theory and Technique of Perspective Projection, III ..... *George F. Bush* 171
Report of 38th SAE Meeting 177
AVIATION's Sketch Book of Design Detail 183
AVIATION's Engineering Data Book 189
Review of Patents ..... *A. Harry Crowell* 192
Factory Maintenance Section:
Proper Care of Compressed Air Plants ..... *Ed. C. Powers* 179
Subcontractor's Section:
Consolidated Subcontract System Coordinates Schedules ..... *Howard G. Golem* 195

Air Transport

Postwar Preview of European Airways ..... *Maurice A. Garbell* 202
Shifting Prospects for Airline Revenue and Profits ..... *Raymond L. Hoadley* 205
Complete Mobile Fire Protection Units 209

Maintenance

Aircraft Service Organization—The Gateway to Sound Operation *Arthur L. Fornoff* 211
Dynamic Balancing in Propeller Maintenance ..... *B. J. Cumnock* 214
Britain's Ground Crews Hit Germany's Factories 217
AVIATION's Maintenance Notebook 219

Military

Designing Gun Turrets as Integral Part of Aircraft, I ..... *L. G. Frise* 227

Flying Equipment

Messerschmitt Me-210A-1 235
Bird-Proof Windshield 237
Sikorsky Helicopter Passes Army Tests 237
Ryan to Build New Navy Combat Plane 237

Civil Operation and Training

Cleveland Courier Service Gets Industry Backing 239
Women Instructors Graduated 239
On Patrol 241
Along the Apron 241

Side Slips 201

New Products

Information Tips on Trade Literature 243
Latest Machine Tools 245
Shop Equipment and Accessories 250

The Aviation News

National Aviation 295
Washington Windsock 299
Calling Names 300
Aviation Manufacturing 303
Assembly Lines 307
Transport Aviation 309
Aviation Abroad 311
Financial Notes 315
Aviation People 319
Book Reviews 321

George W. Pfeil ..... *Publisher*
Leslie E. Neville ..... *Editor*
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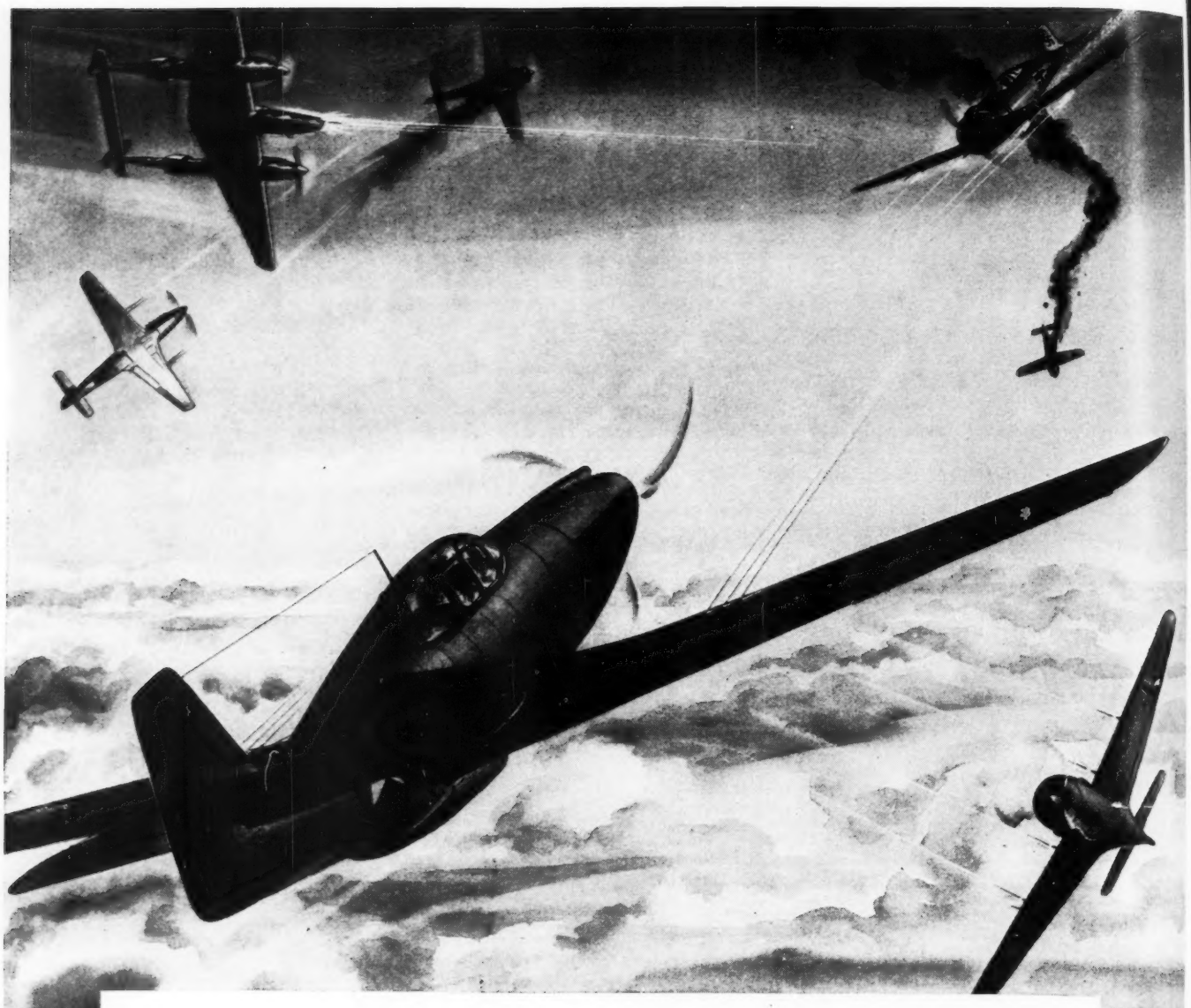

Alert Aides to Busy Airmen

DURING FAST COMBAT, long patrols, and in reconnaissance flights, a pilot's eyes must be everywhere at once. "PIONEER" Warning Units are a major help under such circumstances.

These precision-built instruments watch fuel pressure, oil pressure and vacuum value. When pressure or vacuum reaches a pre-determined low point, a light flashes, attracts the flyer, and thus enables him to take steps to avert trouble.

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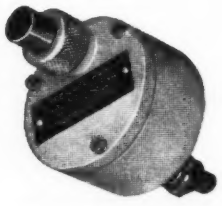


"PIONEER" Warning Units are vital members of "The Invisible Crew" — precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews on every front.

THE INVISIBLE CREW

Precision Equipment by **Bendix** AVIATION CORPORATION

PIONEER INSTRUMENT DIVISION

In This Issue

Just prior to his tragic death, Eddie Allen completed the first of a series of three articles for AVIATION and prepared notes and rough drafts of the remaining two. Al Reed, chief test pilot for Boeing for the last four years, is completing these drafts for the next two issues. Thus Allen's ideas, which have meant so much to the industry, will be presented through the able collaboration of Reed. The first in this series begins on.....**Page 108**

The Controlled Materials Plan is a No. 1 cause for discussion in the aviation industry today. An intimate survey of opinion of both government and industry minds on the merits of the plan as presently contemplated is summarized on.....**Page 114**

Absenteeism is a major problem vitally affecting aircraft production. It is the fault of neither labor or management, but really an inevitable circumstance of the times. However, it remains a serious problem and promises to increase unless definite steps are taken to combat it. A clear-cut analysis of the reasons for absenteeism, its effects, and steps now being taken to control it is presented on.....**Page 116**

Consolidated Aircraft Corp., in its 20th anniversary year, is completing a succession of mergers which will make it the world's largest single aviation company. AVIATION herewith presents an historical summary of how this vast and significant enterprise came to be, and follows up with three feature articles on some of its principal phases of operation.....**Page 122**

Of all the airplane types produced by Consolidated, the B-24 *Liberator* bomber is the greatest quantity production craft. A machine of highly efficient characteristics, it was found to be an ideal model for conversion into cargo as well as bomb carrier. The conversion is called the C-87 *Liberator Express,* and through a magnificent design and production achievement, both B-24's and C-87's are rolled off the same assembly line at Consolidated's Texas plant. How it is done is described beginning on **Page 126**

Modification Centers are an American production innovation which give our fighting forces *tomorrow's* airplanes *today*—one jump ahead of the enemy. The first detailed description of this important production phase, designed to relieve quantity production lines of back pressures built up by myriad engineering change orders, is presented in this issue by Glenn Hotchkiss, of Consolidated.....**Page 134**

Arthur L. Fornoff, Director of Service, Bell Aircraft Corp., whose article on page 211 describes the aircraft manufacturer's service organization as the gateway to sound operation. Mr. Fornoff is not new to AVIATION readers. Most will remember this significant article appearing in the Dec., 1941 issue, after he had established the Bell service organization in England. His basic philosophy unchanged by the spreading of his activities to a truly global basis paralleling the spread of the war, Mr. Fornoff marshalls an even more imposing array of reasons and facts to demonstrate the value and need of organized service by manufacture.

Knowledge of plastics is becoming more and more essential in aircraft design. Their application is rapidly becoming widespread and will increase in the future. For the first in a series of articles describing the characteristics of plastics applicable to aircraft structures, see "Points on Plastics".....**Page 141**

Good tool planning is necessary for successful quantity aircraft production. First of two articles describing 20 points in making job analysis prerequisite to tool planning appears on....**Page 144**

Visualization of airflow has been a factor of prime importance in the advancement of the science of aerodynamics. An article reviewing important preliminary work in this technique, together with a description of the author's original work in designing apparatus to carry airflow studies to a more advanced stage, appears in this number..**Page 148**

Another advancement in the art of reproducing loft layouts is the Photoprint Process. It is described in detail beginning on.....**Page 154**

Continuing the important series on design considerations for plywood structures, the fourth article goes beyond the fundamental considerations of weight saving in discussing innovations in wing design which results in considerably improved structures and economy in materials and costs of fabrication .....**Page 164**

Proper care of compressed air installations is the feature article in the Factory Maintenance Section. Listed as "critical machinery," air compressors must be properly cared for if production interruptions are to be avoided.....**Page 179**

In the Subcontractors Section, the Consolidated system for coordinating schedules is described—a new approach to work dispersal as a measure to meet the special manpower and material problems .....**Page 193**

Post War airways in Europe will be an important factor in the rehabilitation of that devastated continent and will have a considerable effect on the peace. In the Transport Section is an article that provides much food for thought on the subject.....**Page 202**

Also in the Transport Section is a comprehensive review of the shifting prospects for airline revenue and profits by AVIATION's financial editor....**Page 205**

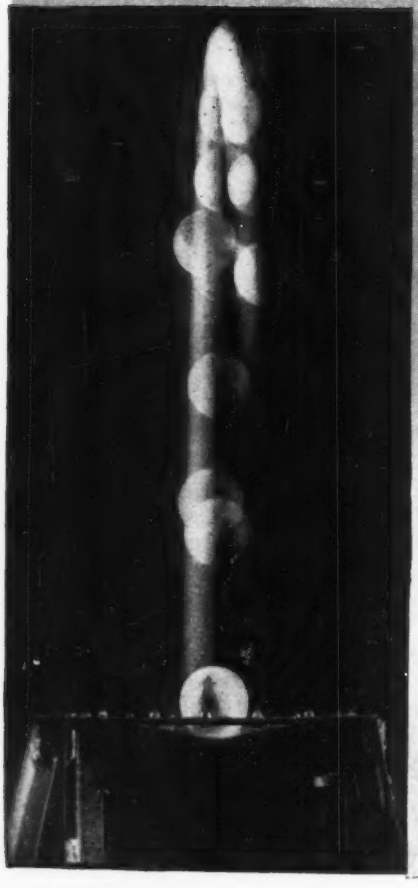
In the Military Section is the first in a series of articles outlining the development of gun turrets for military aircraft. These articles contain a most comprehensive series of sketches of turret mechanisms, and this first installment covers the construction details of the famous Bristol turrets, widely used in Great Britain.....**Page 227**

A summary of papers presented before the 38th annual meeting of the SAE at Detroit appears on page 177. In the Flying Equipment section, (page 235) there is a description of the new German fighter-bomber, the Messerschmidt 210A-1.

Among the other regular AVIATION features to be found in this issue are the Sketch Book of Design Detail (page 183); Engineering Data Book, giving the most up-to-date specifications for aircraft steel tubing and purchasing instructions (page 189); and the Maintenance Notebook.... **Page 219**

When plane windows need impact strength

Aero Quality LUMARITH *has it*



When twelve pounds of wild bird-life makes a suicide dive at 60 miles an hour, the plane's transparent plastic windows have to be able to take it.

High impact strength is an outstanding characteristic of Aero-Quality Lumarith which adds to the military stamina of many United Nations' planes.

Among the many other features of Aero-Quality Lumarith, its protection for the airmen against severe sunburn is of particular interest.

The Aero-Quality formula of transparent Lumarith screens out the invisible rays which produce irritating sunburn. Other Lumarith formulae transmit up to 80% of the health-giving ultra-violet rays. This feature is just one indication of the versatility of this outstanding plastic.

Celanese Celluloid Corporation, 180 Madison Ave., New York City, a division of Celanese Corporation of America Sole Producer of Lumarith* and Celluloid plastics. . . . *Trademarks Reg. U. S. Pat. Of. Representatives: Cleveland, Dayton, Chicago, St. Louis, Detroit, San Francisco, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa

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The First Name in Plastics

CELANESE CELLULOID CORPORATION

LEFT—The repetitive flash photograph by Gjon Mili shows ⅛" sheet of Aero-Quality Lumarith taking full force of free-falling 12-lb. ball—with flashes of resulting rebound. ¼" stock withstands drop of 36 ft.

A DIVISION OF CELANESE CORPORATION OF AMERICA

Food—The Deciding Issue

Our food problem remains to be solved

THE first thing the Germans did when they occupied Czecho-Slovakia, Poland, Belgium, France – was to empty all warehouses. Everything went into trucks headed for Germany.

The Nazis knew that this war would be won by the army that had the most supplies and the best supply system.

The Nazis knew that supplies are as essential as guns. They knew that the most essential of all supplies is . . . food.

Being the only people on earth who can watch women and children starve, the Nazis seized upon food as their most powerful instrument for disciplining the masses. They added famine to their arsenal of conquest.

The flocks and herds of Europe are being consumed with alarming rapidity. The desperate shortage of meats and fats is growing steadily worse. Our Allies are short of certain foods that we must supply if we expect them to carry on.

And as we supply them, as our imports are curtailed, as our fighting men consume more than they do in civil life, and as we fail to increase our production rapidly enough . . . we, too, become short of certain foods.

Former President Herbert Hoover, speaking before a conference of the Governors and Representatives of twelve Mid-Western farming states in Des Moines on March 15th, sounded the warning that American agriculture, beset by Washington bungling on manpower, farm machinery and price systems, strangling production and distribution, is facing a deterioration which may bring on a national food shortage such as led to the collapse of Russia, the defeat of Germany in the first World War and the fall of France in the present war. Unless this deterioration is stopped, warns Mr. Hoover, we cannot hope to win the present conflict.

Complications of similar magnitude face the food processor and the distributor.

Never in the history of the world has man's dependence on food been so crucial. Yet it is not easy for us to grasp the full significance of the crisis. We are so accustomed to finding milk, eggs and butter on our doorsteps every morning, we are so used to filling our pantries from the shelves of our grocers and markets that we accept food as something that is due us on demand. We do not stop to think that we never are more than a few meals ahead of famine.

But this picture has changed. Now we are faced with food rationing, and every day the shelves of our food markets become more bare.

* * *

Let it be noted that the appointment of two Food Administrators has not solved the food problem. It is still with us; daily it becomes more critical. Unless it is solved, and solved quickly, the very food that ex-Food Administrator Wickard said would "win the war and write the peace" may lose the war and lose the peace.

Put very simply and clearly, the food problem amounts to this: we are trying to feed upward of 200 million people. We are trying to do it with the farms and other facilities that heretofore have been capable of feeding about 145 million people (our present population plus a 5% surplus).

Had the Government foreseen the need and planned ahead, we could have begun by 1941 the enlargement of our farm production and food processing capacity. Two irreplaceable years have been lost!

The gravity of the situation becomes apparent when we consider that 50,000 factories are required to process our foods. Food processing not only is America's biggest industry – it is one of America's most important for, without processing, most foods would perish before they could reach the consumer. The term "processing" covers the salting, drying, smoking, pickling, chilling, canning, packing and other methods of preservation that make it possible for us to eat in 1943 food that was produced in 1942. Few realize that most of the food we shall eat in 1943 was produced and processed last year, that most of the seed we plant this spring will grow food for 1944 or perhaps later.

In one important process of preservation, tin and rubber are vital materials. When the Japs captured Malaya and the Netherlands East Indies more than half of the world's tin and nearly all of its rubber fell into their hands. This forced drastic changes upon our entire food economy. The importance of tinplated steel containers, tops for glass jars and rubber gaskets is fairly obvious . . . metal food containers alone consume, every year, more than 2,700,000 tons of steel.

The aggression of Japan has snared our whole food industry in a maze of intricate packing problems. It has enforced recognition of a new principle of food technology, i.e., that the *method* of food preservation is determined by the *type* of container available. The tin, steel and rubber stringency compels many food processors to adopt

unfamiliar methods — methods that call for a great deal of new equipment. This, in turn, involves the use of critical materials that are so urgently needed for other war purposes.

This conversion of the food processing industry to meet these exacting restrictions has been greatly complicated by two factors that have increased its wartime burden. Indeed, it is these that provide the principal reason for civilian food rationing.

The first of these is the task of feeding our armed forces overseas. Allied ships are being sunk at an alarming rate and the loss of cargo is considerable.

The second factor gravely augments the first. Under Lend-Lease our country is undertaking to feed our Allies to the extent of approximately 60 million people.

Types of food required for Lend-Lease and the armed forces are the finest we can produce. They are the high protein foods, especially meats, cheese and milk; and the protective foods which rate high in vitamin content. Peculiarly enough, the more valuable a food is from a nutritive angle, the more specialized is the processing required to preserve it.

The food processing industry, handicapped as it is, is meeting today's challenge with resourcefulness and enthusiasm . . . despite container complications and shipping shortages.

This is the tenth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

It is accomplishing its Herculean task by resurrecting and modernizing a method of food preservation that is as old as mankind. Probably you have read a great deal about dehydration. You actually may have eaten dehydrated food, but right now nearly every bit of dehydrated food is earmarked for the armed forces or for Lend-Lease.

Food processing never will be as spectacular as the production of bombers or tanks. But under today's conditions, the performance of the food processor is no less important . . . no less inspiring. When we consider that dehydrated food is compressed into solid blocks with a density nearly equal to that of coal, so that almost a whole meal can be carried in a vest pocket, and that half of the shipping space is thereby saved in transportation, we begin to appreciate what the processors have contributed to meet the food problem imposed by the war.

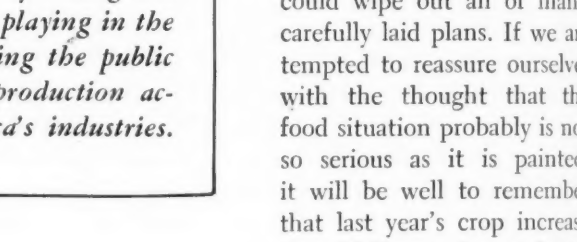
But they have not only contributed new methods, they are achieving new highs in production. And now they are asked to do what borders on the impossible. Consider dehydrated egg powder. Normal production in pre-war years was about 3,000,000 lbs. In 1940 this was increased two and one-half times, in 1942 it was stepped up again, this time forty-fold. And in 1943 the call is for another 60 per cent boost, to make a total of 480,000,000 lbs. Dried milk powder production of 350,000,000 lbs. in 1940 must be increased to 685,000,000 lbs. in 1943.

Vegetables, which were a small item to the processor before the war, now are dehydrated in enormous quantities. The vegetable dehydration industry has had to grow by leaps and bounds without benefit of the high priorities accorded to arms, ship and aircraft building. Production of dehydrated vegetables in 1942 was four times that of 1941, and 1943 calls for a sixteen-fold increase over 1942.

Total dehydrated food production in 1943 is scheduled at 1,750,000,000 lbs., dry basis . . . *all for export.* Multiply that by 10 and you have a rough approximation of the astronomical amount of raw materials that will have to be produced.

Many problems remain to be solved in the troublesome days that lie ahead. But with all his resourcefulness, man has little control over the weather. A severe drought could wipe out all of man's carefully laid plans. If we are tempted to reassure ourselves with the thought that the food situation probably is not so serious as it is painted, it will be well to remember that last year's crop increase over 1941 was due to better than average growing weather.

The war-bred food crisis that now confronts us will be met only by immediate measures to insure a food production ample to allow for adverse weather conditions. The food processing industry is capable, but has not been granted the needed help, in coping with its tasks. The food problem as a whole involves all three functions of production, processing and distribution. And if we are to master the problems that now beset us, all three of them must be coordinated under a single administrative control. "Food will win the war and write the peace". But if American food is to do that double job, we must develop a capacity for food *administration* comparable with the genius of our food industries.



President, McGraw-Hill Publishing Company, Inc.

New Appointment Will Strengthen WPB Production Set-up

MOST OF US learn quite early in life that when you are sick, you consult a physician; when you are sued, you seek the advice of an attorney. These truths are held to be self-evident . . . everywhere but in some parts of Washington. And so it is refreshing to learn that broader responsibilities for the aviation production program are now in the hands of a man who knows the business—Theodore Paul Wright.

The program has benefitted since the beginning from Ted Wright's broad experience in aviation. In fact, much of the credit for the basic soundness of the production effort can be traced directly to his straight thinking. But it required the keen insight of Charles E. Wilson to recognize that he had this valuable talent in his own organization and to make full use of it in his recent reorganization of the Aircraft Production Board.

T. P. WRIGHT went to Washington as consultant to the old National Defense Advisory Committee in the spring of 1940. After working closely with the Army, Navy, and the industry in laying the foundations for the orderly expansion of the industry, he returned briefly to his former job as vice-president and director of engineering for Curtiss-Wright. Then, early in 1941, he went back to Washington (at a substantial personal sacrifice) to become assistant chief of the aircraft section of the Office of Production Management.

When OPA was transformed into WPB he continued to keep his fingers on the aircraft program, and last December he organized the present Aircraft Resources Control Office (page 110, Feb. AVIATION). His appointment as director of this office and as a member of the policy-forming Aircraft Production Board was formally legalized on March 6.

Few men know the complexities of the aviation industry and its government relations as well as T. P. Wright. He acquired a knowledge of the procurement side of the picture in his first job as an inspector of naval aircraft in 1920, immediately after being graduated from M.I.T. Turning to manufacturing, he soon became chief engineer of the old Curtiss Aeroplane & Motor Co., where he directed the engineering development of many military and commercial aircraft. His manufacturing experience includes production as well as engineering responsibilities, and he has been a direct and frequent observer of foreign manufacturing methods.

THIS BACKGROUND is tremendously useful for the difficult assignment of balancing the requirements and viewpoints of the Army, Navy, WPB, and aircraft industry. Only a man who knows the problems of both engineering and production and the needs of our armed forces can determine wisely the time when it is most advantageous to feed new designs into the production lines, when to shift production emphasis according to current needs, and how to tackle the material and manpower problems that lie ahead.

Mr. Wilson is deserving of high commendation for this wise appointment. The Army, the Navy, the aviation industry, and the nation have reason for a deeper feeling of confidence in the military aircraft production program than they have ever had before.

Leslie E. Neville

AVIATION'S
WAR COMMUNIQUE
NO. 16

America at War

We grow stronger in air—Germany and Japan weaker. Our airmen triumph in every war theatre, plane production zooms, new formidable fighting craft are heralded, and "Corsairs" see first action. Meantime, home front battles ills of over-optimism to hasten packing of Victory "pipeline" so "100 planes fed in this end will hurtle 100 from business end against enemy."

ASKED TO SELECT the ten outstanding developments of recent date relative to America's air war efforts, no two people would come up with precisely the same choices. But the majority of such lists would include most of the following:

Army Air Force day bombing of Europe has become an established success, though Gen. Eaker recently found it propitious to allay misunderstanding of it.

Weight of our Oriental air blows has brought Brig. Gen. Claire Chennault, commander of the China Air Task Force, to say that the Japanese air force has hit its peak and is now on the down grade. (Churchill months ago said the Luftwaffe was declining.)

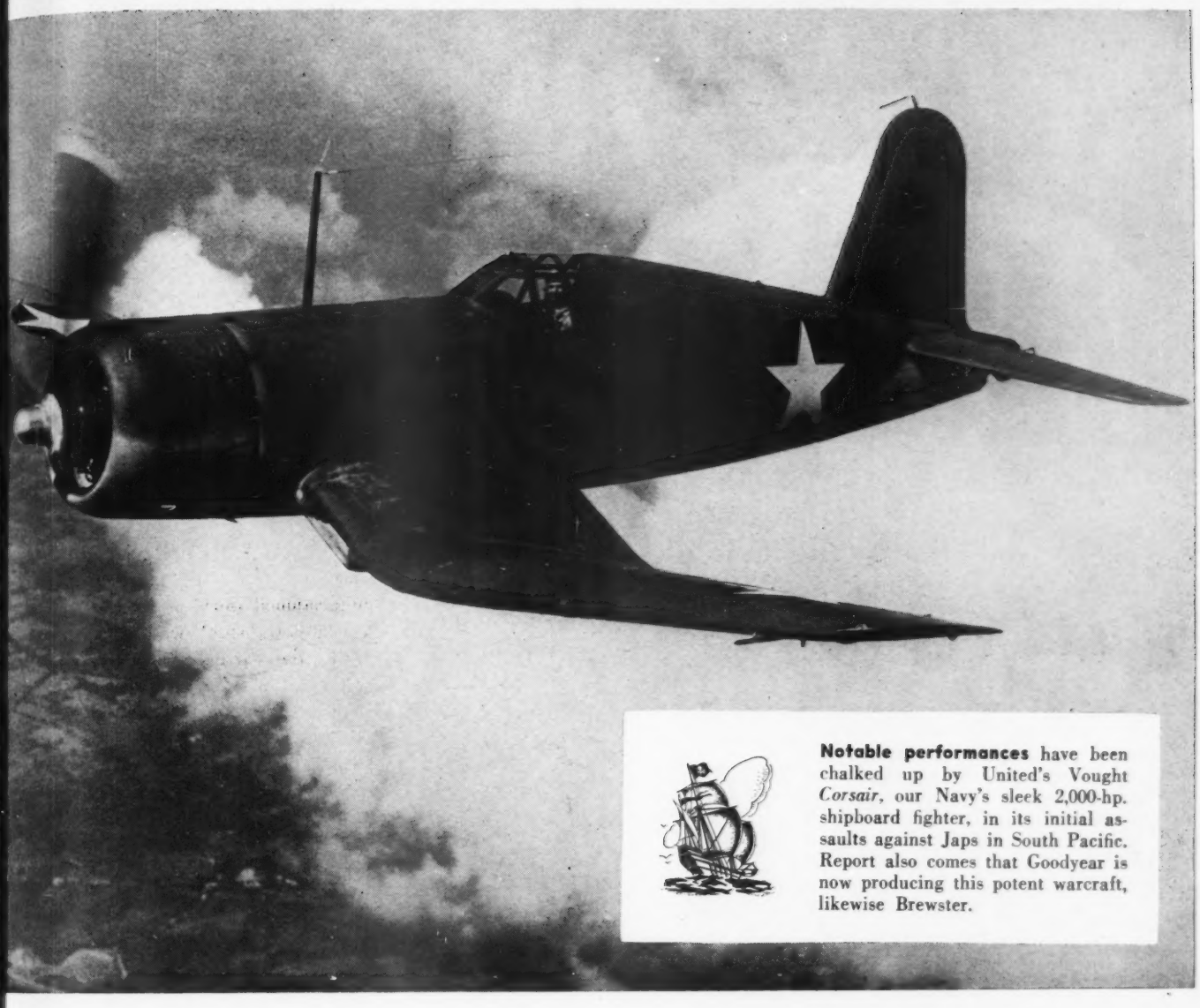
War Production Board officials state, though not for specific quotation, that we will hit a plane output rate of 12,000 per month in December; that we will come pretty close to the '43 quota now put at some 104,000; and that we could build about 150,000 in '44. Question whether we and our allies can use that many has still to be answered.

United States air power alone, in 1944, will be superior in planes and manpower to that of the entire Axis, according to Maj. Gen. I. H. Edwards, Army assistant chief of staff.

That Germany may collapse sooner than expected has come to be the belief of more and more persons who are in a position to judge. And fewer people think she can stand another winter after the next one. The Russian Army meanwhile is hurting the Nazis worse than anything else, and next in weight to this Soviet attack is the Anglo-American air operation.

The Senate Truman Committee, a special group investigating war production, is conducting a continuous inquiry into operations at aircraft plants. The

Axis-smashing output of 12,000 warplanes per month is foreseen by next December. This points to mighty 150,000 potential in 1944, raises question: Will victory require such a huge armada? Seen (left) is Boeing plant speeding *Fortresses*, Consolidated (below) rushing *Liberators*, four-engined ships which are scoring consistently in day bombing over Continent.



Notable performances have been chalked up by United's Vought *Corsair*, our Navy's sleek 2,000-hp. shipboard fighter, in its initial assaults against Japs in South Pacific. Report also comes that Goodyear is now producing this potent warcraft, likewise Brewster.

committee was moved to special activity lately by complaints from the Army that some types of needed planes were not being delivered.

United's 2,000-hp. Vought shipboard fighter, the F4U *Corsair*, has gone into action in the Pacific. At the same time, Goodyear announces it is producing *Corsairs* in their entirety, and Brewster Aeronautical, too, is building them.

The Army has several new airplane designs, some in the final paper stages and some in the air, which move even the engineers at Wright Field to the use of superlatives. But most informed persons believe that the war will be fought and won for the most part with existing standard types.

The Anti-Submarine Command of the Army Air Forces, organized to take over the coastal patrol functions of the First Bomber Command, has extended its operations across the Atlantic. And that is just one stab at the iron fish (still the most formidable of all Nazi weapons) which are being slowly but surely beaten by laborious attack and laborious building of vessels.

And let us append mention of a sort of odd-time occupation—the airplane builders are crystalizing some plans for converting their overgrown capacities to various other goods after the war, including such items as cars and houses.

One trouble with any such present definitive summary of our part in the war is that it accents the optimistic. And we may well pause and give ear to those hard-headed souls who never supercharge their hopes above immediate altitudes. They are the men who say: "To predict the toppling of the Axis by such-and-such a date—when the U-boats still range the seas unlicked, when the enemy still retains a hold in North Africa, and when an Allied bridgehead on the Continent is yet to be forced—is foolhardy."

Surely, we have a big job parrying the troubles of over-optimism. War manufacturers say that every time a series of good war reports come in, the workers take a layoff or start poking around. The whole country lets down. Nobody on our side likes that. We want to keep up full steam in order to knock out the enemy as quickly as possible in order to end the enormous cost.

Everybody now knows that the Allies have the wallop to do the job. If you will look at a map of the world

(*Turn to page* 395)

Edmund T. Allen

BEYOND the present world upheaval there is a greater fight for freedom that transcends the military might of dictators. It is the eternal struggle of all mankind to harness nature. The miracle of flight is but one example of battles won in this war for emancipation. The legions of science are poised at the threshold of even greater things involving forces so powerful that the human race dare not risk their possible use for destruction rather than creation. We must win this war in order to keep these forces in responsible hands.

There is vast creative satisfaction but little glory for the pioneers of thought who labor on the fringe of the unknown. Often there is martyrdom. The bacteriologists who have fallen victim to the diseases they conquered, the atom smashers who may some day find themselves within the sphere of some reaction they create, the aerodynamicist who must test new design theories under dangerous flight conditions to insure safety for others are no less heroic than the military leaders who fall in battle.

The aeronautical sciences have had their full share of martyrdom. Those of us who have followed the industry through the years have cultivated a protective shell against the shocks that come to us from time to time. But the inadequacy of this defensive mechanism becomes apparent when we learn of such losses as that of Edmund T. Allen.

Eddie took no furloughs from the front lines of achievement. He was possessed of a rare gift for combining theory and practice in the most useful proportions. His work on cruising control in scheduled operations in collaboration with W. Bailey Oswald (AVIATION, Feb., 1934-June, 1935) gave the first real meaning to air transport schedules and showed the way toward more efficient, reliable, and safer air travel. The development of this technique, which enabled the airlines to follow flight plans assuring on-time arrivals, contributed importantly to the unquestioned world supremacy of American air transport which was achieved during the thirties.

American military aviation would have achieved supremacy at the same time if the nation had heeded Eddie's warning. He was the first American observer to report on the rebirth of German Air Power following a European visit in 1935. His alarming discoveries were then presented in this publication in a series of three articles, Dec., Jan., and Feb., 1935-1936.

Another profound impression resulting from his European trip was a keen appreciation of the thoroughness of flight test procedure on new aircraft by the Germans. Up to that time we had been content to rush through this important phase of development quickly and iron out the remaining bugs in subsequent operations. Eddie resolved that he would find ways to improve our test procedure to the point where it would exceed that of the Germans in completeness and he set about the task. It was in this work that he was most recently engaged, and as a result the Wilbur Wright Lecture was added to his long list of honors. In accord with his customary practice, he desired that his latest works be reported in AVIATION. And the first of his last three articles appears herewith.

The conquest of time and space and the progress of our present military efforts will be retarded by the loss of Eddie Allen. The work he has done is a cornerstone in air progress, and the able men of the organization he has built must carry on. Theirs is a rare heritage and a sharp challenge to do the job as he would have had them do it.

The late Eddie Allen, renowned test pilot, head of Boeing's Flight & Aerodynamic Div., and author of this article, making final adjustments on a wind tunnel model of the Boeing *Stratoliner*. An engineer and scientist, Mr. Allen contributed much to the aerodynamic refinements of aircraft.

Flight Testing Is a Sound Business

By **EDMUND T. ALLEN**

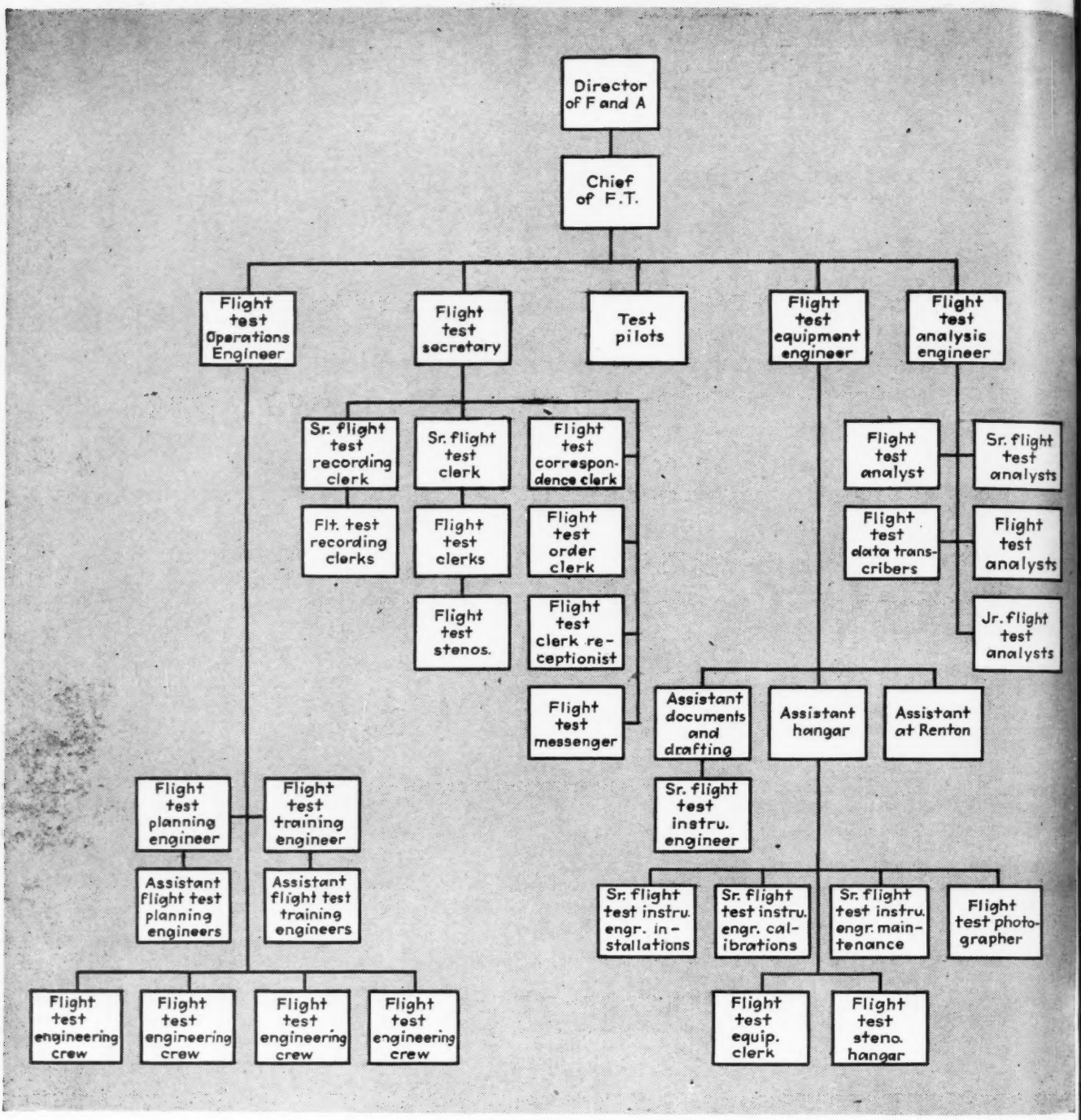
Director of Flight and Aerodynamics, Boeing Aircraft Co.

Edmund T. Allen gave his best efforts—and finally his life—to the advancement of the major science of flight testing. In this first of three significant articles comprising his last written contribution he has outlined the vital purpose of his work and revealed the careful organization of his personnel and the structure of his department.

A PROTOTYPE of the test pilot, according to the usual story told by fiction writers and motion picture producers, is a daredevil sort of fellow, not infrequently long on courage and short on brains, who takes up a newly designed ship, whips it through the air a few times, then goes into a vertical dive that ends in a 9G pull-out. If the wings don't fold up, the ship is pronounced safe and the company goes into production of the new model. What happens to the test pilot during the intervening years while this model is being produced has never been revealed by fictioneers.

Actually, flight testing today is not a spasmodic, haphazard, daredevil occupation. For some years it has been a sound, scientific business, operating continuously to perform a design function on a quantitative basis.

Like any other product requiring engineering, an aircraft should fulfill completely and satisfactorily the purpose for which it is intended. On some occasions in the past it has been necessary to establish proof of this fulfillment by long usage and experience, most frequently not on the part of the manufacturer, but on the part of the owner or operator of the aircraft. Information pertaining to this type of operation seldom, if ever, reaches the manufacturer, and in the few instances when it does arrive the information is in such a form that it is of little or no use. In the past, a gap has existed between airplane design and operation.



Organization chart of the Boeing Aircraft Co.'s Flight & Aerodynamics Div.

Bridging this gap is the function of modern flight testing organizations.

Flight testing can be, and at the Boeing Aircraft Co. for the past three years has been, essentially quantitative. The spasmodic nature of flight testing as depicted in imaginative minds has long since been replaced at Boeing by a continuous project in keeping with the realization of the fundamental design objective. It is the opinion here that modern flight testing should consist of far more than merely the initial flight tests associated with newly designed aircraft. It should provide, among other things, a continuous, uninterrupted method of solving service operation problems and a means of providing operators with this information prior to delivery.

Very few design elements can be determined completely without information which can be obtained only through actual flight tests. The wind tunnel, the test shed, the cold room, and the stratochamber all work in complete unison to produce likely or probable solutions to the many engineering problems. However, the final and acid test can be obtained only from actual full-scale tests under actual flying conditions. Flight testing comprises:

1. Testing a new model for performance and operational guarantees.

2. Development testing to obtain design information corroborating (a) mockups, (b) simulated laboratory tests, (c) theoretical studies, and (d) model tests.

The outstanding example of an airplane whose essential components were designed through rigid and thorough flight testing is the Boeing B-17E *Flying Fortress*. With the capabilities of the flight test unit, in conjunction with the aerodynamics and engineering design units, all important items and changes were proved by actual flight on an earlier model of the B-17 series. Included in the items tested under flight conditions before the "E" was given a final stamp of approval and put into production, were details of the power plant system, structural innovations,

During the early days of the Boeing flight testing department. A high-altitude test crew is about to board one of the initial model *Fortresses* for a flight to secure data on the operation of the plane at stratosphere levels.

aerodynamic refinements, such as the now famous Boeing dorsal fin, and other items involving stability and control.

Also tested under flight conditions were items associated with armament and also the tactical use of this now famous plane. When the first Boeing B-17E emerged from the production shop, it was a completed plane. No long period of service was required to prove the vital changes that had been incorporated. They had already been proved in hundreds of hours of quantitative full-scale flight testing. Following the customary checkout flights, the first and all subsequent Boeing B-17E's were ready and fit for delivery.

At the Boeing factory, the Flight and Aerodynamics Division has been organized on a parallel footing with Engineering, Manufacturing, and other divisions. The autonomy of the flight test unit permits it to:

1. Establish the priority of tests if the authority is so delegated.
2. Control tests and delegate items and equipment in proportion to the relative importance of the tests.
3. Gather the background common to all design units on problems of flight testing.
4. Obtain proper coordination with all design units.

This makes for individual integrity of all divisions and yields optimum results from flight testing.

Within the Flight and Aerodynamics Division are two separate, but not divorced, functions—flight testing and aerodynamics. These two groups work in close harmony with one another and enable close coordination with engineering, production, and other divisions of the company.

As a flight test unit's function is to provide the manufacturer with information dealing with either operation or characteristics of an aircraft in flight, the handling of this information is of paramount importance. Data obtained during flight testing are of equal, if not greater, importance than any other engineering information on the aircraft, for flight test information provides the proof, or final answer. The flight test unit should attempt to disseminate unprejudiced, unopinionated, understandable information of reliable accuracy as rapidly as possible. Information which is untimely is likely to be not only devoid of usefulness, but may cause misunderstanding or suggest inefficiency. Proper method, adequate personnel, and

proper organization again are the solution.

At Boeing there has been established a hard and fast rule that immediately following a test flight, the entire crew gathers in the conference room, accompanied by a stenographer. The flight and all aspects of the tests are discussed by the crew, and tentative conclusions are reached. It is the purpose of these conclusions to direct the course of further testing, to indicate the results accomplished and the scope of those results, and to assure that the information is consistent and comprehensible.

The film from the recording camera is hastened to the flight test darkroom, where it is processed and the results projected on enlargement paper. The rough draft is corrected and turned over to the clerical group which mimeographs it during the night. The photographic results are sent to an analysis group which breaks down the various tests and prepares graphs and charts on the results of the test flight. This information is rapidly duplicated and added to the mimeographed report. By noon of the following day every interested person in the Boeing plant has a complete preliminary report on the flight test.

Every attempt is made by the flight test unit to avoid a blind collection of data which has not been evaluated for accuracy or usefulness in deriving results. The value of the results is decided upon through proper collaboration with the design units. The group must be thoroughly conversant with the details of the tests proposed and being conducted, in order to conduct the tests intelligently and contribute to the detailed technical solutions.

As the flight test group is the only unit in the company which comes into direct contact with the problems that confront the operators of aircraft produced, it cannot be casual or haphazard in its approach to these problems, nor should it be hampered in presenting the truths resulting from the actual flight test. The devotion of a flight test group to this policy will in later years be reflected in the volume of future business which the manufacturer enjoys.

Because a flight test unit, in the performance of its duties, is operating in conjunction with so many various engineering groups in an organization, this single group must determine the test priorities. Especially in these days of war, the importance of this phase cannot be over emphasized. In some instances the purpose of a test may be to obtain information of academic interest only, and, as such, is integrated into the over-all program by the Boeing flight test unit on the basis of importance for use in the final military article, which at present is the Boeing *Flying Fortress*.

In determining the priorities for test items, the Boeing company took cognizance of the fact that the tests were to be made on large four-engined aircraft, a manufacturing field in which Boeing pioneered. A major portion of the flight testing is in the stratosphere beyond the boundaries of general human knowledge. Sending an aircraft and crew into this region during the early days of Boeing's high altitude research was never considered as the safest occupation in the world. But every known safety precaution was taken.

Although the early hazards in this type of testing are now considerably reduced, the cost of high altitude flying has not been overcome. Sending a large four-engined aircraft such as the *Flying Fortress* to 35,000 ft. or better represents a cost of about $1,000 per hour. For sound business practices it was necessary to devise a method of making each test flight as productive as possible. Single flights have accomplished tests on more than a score of items, and in some instances the item to be tested is checked for a dozen or more consecutive flights, depending upon the nature of the item.

When an engineering group at Boeing develops any item which will require a flight testing, a preliminary outline of the item and the test desired is submitted to the flight test unit. Here the flight test unit evaluates the item against the other tests that must be made.

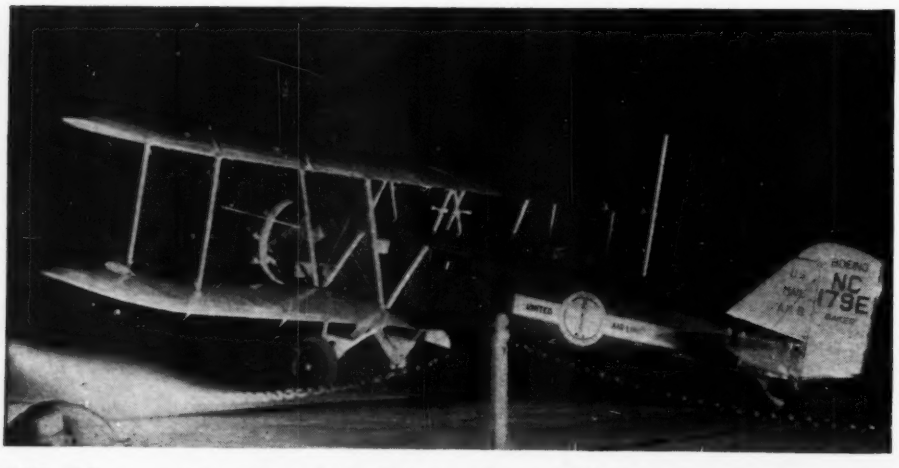
From the preliminary outline, the flight test engineers work out the details of the test, planning and organizing the material necessary, and scheduling any special equipment installations which must be made on test airplanes for the inclusion of the particular test items involved.

In the event that the particular test item is of such nature that the information contained in the preliminary outline is insufficient for the flight test unit to make plans, a second and more extensive outline, including blueprints, is submitted. After the test item has been scheduled and the planning completed, the director of flight and aerodynamics, the chief of flight test, the flight test operations engineer, the flight test equipment engineer, and the flight test analysis engineer meet to discuss the test. Included in these conferences are also other parties concerned.

The discussion centers around the test in general, the portion of the aircraft involved, and the results desired. For each, an explanation of the manner in which it is related to the entire problem, and a statement of accuracy of data required, is given. The flight test equipment group will then obtain or design the instruments needed, with the range and accuracy required, and in the case of a new instrument, a description of it will be prepared.

Prior to the actual test flight, the test crew, usually composed of ten men, meets with the flight test operations engineer and the chief of flight test, and the entire test program for the flight is reviewed, with each item explained, so that every member of the crew will thoroughly understand his part.

Preflight conferences last from 30 min. to 1 hr., and as a measure to insure that each member of the crew will fully understand his part in the test, the head of the engineering units involved in the comprehensive flight test, and the representatives of accessory manufacturers, if they are involved, stand by to answer any specific questions or provide additional information. The crew, each man armed with a flight test plan, a mimeographed form which includes every item on the test, and his particular function for each item, leaves the conference. Thus, each member has a thorough understanding of his duties for the test in question.



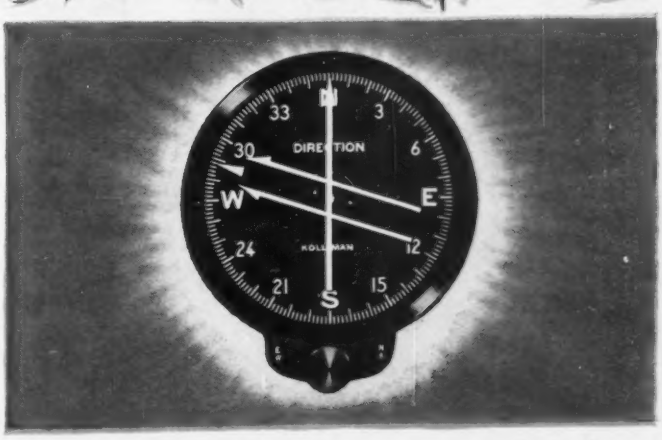
Eddie Allen was inherently a test pilot—first, last and always. Even when he was flying the mail—some of the time in Boeing 40's such as that shown here—he was known as "the flying professor" because of incessant experiments to add to his and the world's knowledge of aircraft and flying.

"She takes me there and she *Brings me Back!*"

"MAYBE ORPHAN ANNIE'S not as pretty as she used to be. Jap AA has lifted her face a few times, and her skin's lost that school-girl complexion. But she takes me where I'm heading for, and then she *brings me home.* And the dials on her instrument panel are the sweetest sight a man can see when he's five hours out and getting homesick."

"AFTER THE WAR, my wife will probably have *her* say when we shop for a family plane. She can have her choice of color, but I'll choose the instruments—*precision* instruments that can take it when the going gets tough, and still tell the *truth.* When I fly, I want to know where I'm going. With me, it's not *how fast* . . . it's *how sure!*"

KOLLSMAN
AIRCRAFT INSTRUMENTS
Product of
SQUARE D COMPANY



TYPICAL of today's fine precision instruments is the Kollsman Direction Indicator. Its easy-to-read dial corresponds to the compass rose appearing on all navigation charts. The reference index pointer can be set to any desired heading by turning the knob at the bottom of the dial . . . and a steady course can easily be held by keeping the pointers matched.

Aviation's Place In the Controlled Materials Plan

By JOHN FOSTER, Jr., *Associate Editor, "Aviation"*

It will work, says WPB — "if," say manufacturers. Modifications necessary for plan's success appear imminent through government-industry cooperation.

WITHOUT DOUBT, the Controlled Materials Plan which goes into effect this month is the most important single document with which the aircraft industry will deal this year.

Whether or not the industry will continue to perform production miracles will depend largely on the success or failure of this plan. And success or failure of CMP will, to a great extent, depend on the industry itself.

The War Production Board, which is charged with administering the plan, firmly believes it will—and must—work. That it can work, the industry agrees, but with some "ifs".

These facts today stand out in the welter of confusion which has surrounded CMP since it was first presented. This, too, can be set down as a fact: That the industry's "ifs" can be taken care of so that it will continue to get today's airplanes in the air today. No one realizes better than the WPB that no plan governing an industry as big as the world's largest can be in-

• The Controlled Materials Plan, like other industry-wide documents, brings with it a new set of terms which must be precisely defined to assure clear understanding by all parties involved. Since aviation management will hear these terms more and more as the year progresses, some of the more important definitions are presented here:

CONTROLLED MATERIALS: Aluminum, carbon steel, copper, and such other materials as may be prescribed, in the forms and shapes indicated in the CMP Materials list, or as otherwise ordered by the vice-chairman on Program Determination.

BILL OF MATERIALS: A statement of the amounts of materials required for physical incorporation in the production of a given product, including the portion of such materials consumed or converted into scrap in the course of processing.

CLAIMANT AGENCY: The following government agencies, plus such others as may from time to time be designated—War and Navy Departments, Maritime Commission, Aircraft Resources Control Office (which uses the Aircraft Scheduling Unit as its working agent for AAF and Bureau of Aeronautics), Office of Lend-Lease Administration, Board of Economic Warfare, and Office of Civilian Supply.

REQUIREMENTS: A statement of the amount of material called for by a program or group of programs, including material consumed or converted into scrap during processing.

ALLOTMENT: A determination (a) by the Requirements Committee of the amount of controlled materials which a Claimant Agency may receive during a specified period, or (b) a further determination by a Claimant Agency, prime consumer, or secondary consumer, as to the portion of its allotment of controlled materials which may be received by one of its prime or secondary consumers.

PRIME CONSUMER: Any person who receives an allotment of controlled material from a Claimant Agency, either directly or through an office of such agency.

SECONDARY CONSUMER: Any person who receives an allotment of controlled material from a prime consumer or another secondary consumer.

AUTHORIZED SCHEDULE: A schedule specifically approved within the limits of an authorized program by a Claimant Agency with respect to a primary consumer, or specifically approved by a primary or secondary consumer with respect to a secondary consumer producing for sale to it as required to meet an authorized schedule.

lexible. And on the industry's part here is the recognition that its needs ust be synchronized with those of anks, guns, and other phases of the ar program.

Fundamental principle of CMP, hich governs *all* American industry, simply that of relating the flow of aterials to the products most required o win the war. As it applies specifically to the aircraft industry, the program is designed to build the maximum umber of planes and engines with the vailable material.

Thus, modifications will be necessary nd, WPB officials maintain, will be ade when necessary to insure the lan's working.

One of the most important of these odifications, from the industry's standpoint, governs re-distribution of aterials.

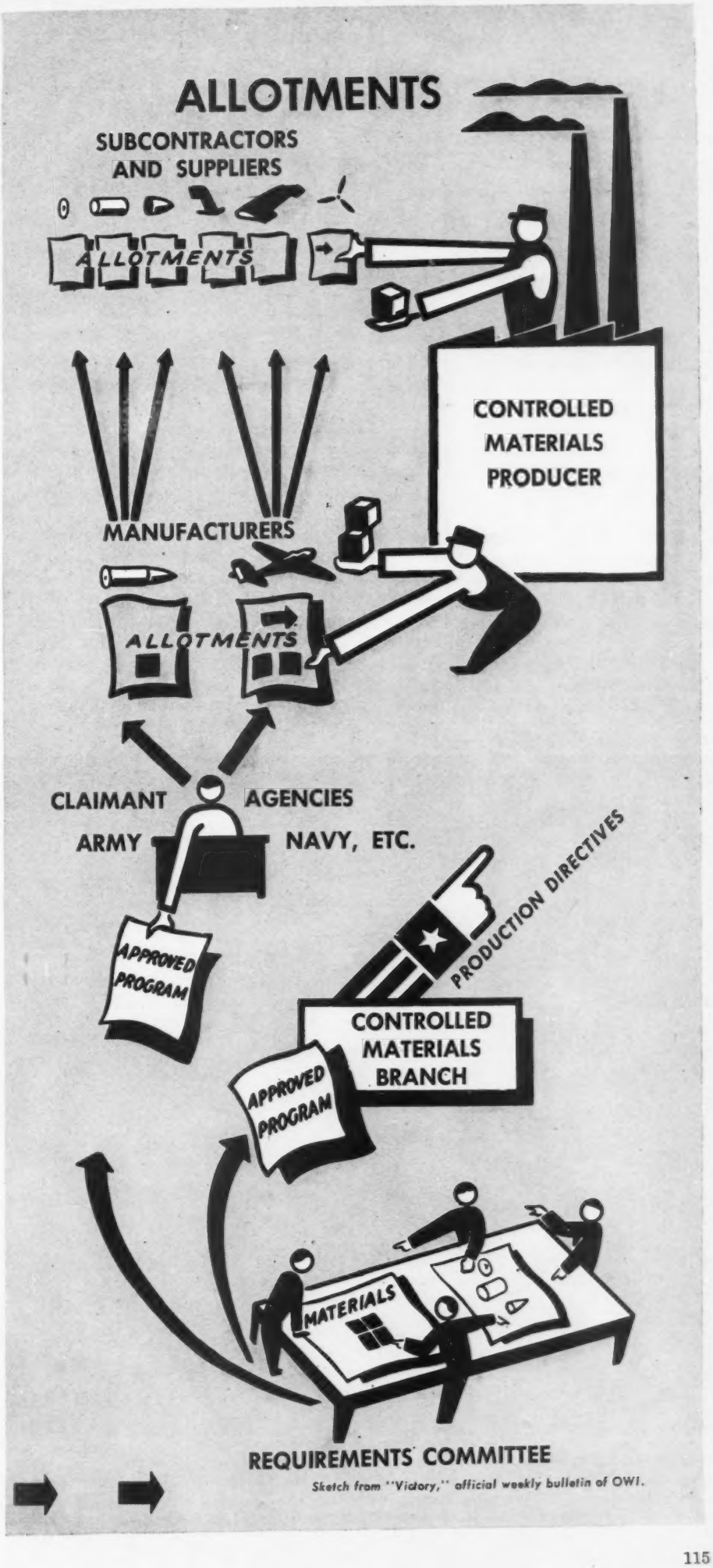
Under CMP, the three present controlled materials—aluminum, steel, and opper—are distributed as follows:

Prime Consumers—in the aircraft industry's case the airframe and engine producers—list their requirements for these materials on Summary and Detail Bills of Materials (forms CMP-3 and 3A, ASU) for a three months' period. These forms from the entire industry then go to the Aircraft Resources Control Office, headed by T. P. Wright, for compilation, analysis, and forwarding to WPB. Then, prior to the beginning of the quarter for which the materials were requested, WPB allocates the materials to the various manufacturers on the basis of their Authorized Production Schedules, and deliveries from mills are started. Three months later the process will, under the present set-up, be repeated.

It is on this point that the industry seeks modification: A speedier means of re-distribution is felt necessary.

In any industry as large and as young as aviation, involuntary surpluses are bound to be built up. With new models constantly coming into production, it is simply impossible to know to the pound just how much material will be needed. Even in some cases where a particular plane has been in production, the aircraft manufacturers have not had the manpower—or the time—to study each and every one of the 30,000 to 100,000 odd parts which make up the completed fighter or bomber. Being human, and wanting to do their production job, they often put their requirement estimates on the high side. But, with constant refinements and improvements

(*Turn to page* 378)



Sketch from "Victory," official weekly bulletin of OWI.

ABSENTEEISM . . . What's the Problem?

A realistic appraisal of the aircraft industry's position analyzing causes and effects and showing how aviation has taken a nation-wide lead in bettering an already-good record.

ABSENTEEISM among war industries has brought a mass of charges as to responsibility—a bewildering array of statistics and a multitude of "cures" ranging from work-or-fight programs to advocacy of prohibition in war plant areas.

What practically every "blast," whether sincere or mere headline seeking, has forgotten is that aviation—which has borne much of the brunt of absentee publicity—is the only industry which has yet made a concerted effort to whip the problem without resort to "remedial legislation."

Working through its two Aircraft War Production Councils, the young plane building industry is the first to attack the problem as it had to be attacked—by finding out the causes of the condition. It is the first industry to offer government agencies tangible means of effecting the cure at the source. This offer has been made through a special subcommittee which is already at work with government officials assigned to the subject.

Absenteeism in the aircraft industry presents neither a rosy nor a gloomy picture. The eight member companies of the Aircraft War Production Council, Inc., on the West Coast had reduced average absences per employee to 6.2 percent by the end of January, and the rate was still going down from a figure of more than 7 percent late last year. Members of the East Coast Council had absentee averages ranging from 5 to 8.5 percent late in February, the over-all rate probably being just about equal to the Pacific group.

Just what these figures mean in terms of time and aircraft production actually lost cannot be accurately measured, despite many blithely quoted statistics. For one of the most serious obstacles the aircraft producers have to hurdle in the fight against absenteeism is the truth of the materials situation; the truth as every employee knows it. Had every employee been on hand every day during some extended periods last year, it is probable that the production rate would have shown little, if any, increase. Materials were the dominant limiting factor.

Since many of the material shortages have been eliminated, absenteeism is at a point where it will count more

Getting the little men who aren't there—the absentee workers—into the picture is not the problem often pictured by headline hunters, for aircraft manufacturers have already initiated the first industry-wide program to solve it. Aviation's absentee record, better than that of many other industries, has shown constant improvement, and the industry's over-all plans may well become the example which others throughout the country will follow. Aviation is first to make industry-wide attack on problem.

d more heavily in the production rve rise. The very knowledge of that t alone by every employee may help count for part of the steady decline absenteeism.

A study of major causes of absenteeism gives a clue to some of the methods ed to combat them by aircraft manufacturers, first as individuals and then rough their Production Councils. The terdepartmental Subcommittee on Absenteeism set up by the federal government lists three general classifications causes, only some of which apply to plants, but all of which contribute rectly or indirectly. They are given low.

First—In-plant problems, subdivided follows:

1. Fatigue. This involves long hours, monotony of work, irregular shifts, lack of employee furloughs. As the average age of workers increases and the percentage of women employees rises, management faces new problems including, for example, the possibility of re-arranging subassembly work and its consequent changes in tooling.

2. Job morale. This can be affected by material shortages, labor pirating, and a dozen other factors. Since it is one of those intangibles, education—or, as one labor leader put it, "ballyhoo"—is necessary.

3. Inadequate personnel policy on absenteeism, such as lack of plant records as to causes, inadequate remedial programs, or lack of labor participation.

4. In-plant accidents.

The second major classification embraces individual employee problems, cluding these:

1. Illness, which has been shown to be greater among older workers and women, who together now account for a majority of aircraft workers.

2. Accidents outside the plant.

3. Home responsibilities of women workers.

4. General lack of morale. Separate from job morale and traced to lack of enthusiasm for winning the war, personal problems, expectation of being drafted, etc.

5. Job shopping. Looking for a softer berth or higher pay.

6. Lack of need for the pay check.

7. Leisure. Resting, taking long weekends, acceding to the yen to go fishing or hunting.

The third major cause of absenteeism mbraces community conditions, such as:

1. Inadequate housing.

2. Inadequate transportation.

3. Rationing and draft board problems.

(*Turn to page* 333)

Idleness of machines due to absenteeism can't all be blamed on "Monday morning hangovers," for there are many other factors—such as materials shortages—which are often beyond the control of either management or employees. Working through their two Aircraft War Production Councils, warplane builders are whipping absenteeism by curing its causes.

• Many headlines have appeared with "startling" absentee figures on the aircraft industry, but few of the statistics quoters have analyzed their figures to show the causes. Here, presented for the first time, is a break-down of absentee reports for a large aircraft producer during one average month.

It shows a good many reasons—neither the workers' nor management's fault—why workers didn't get to the production line and thus were labeled "absentees."

Reasons for Absence	*Number of Employees Reporting*		*Percentage of Total Reports*	
	Men	*Women*	*Men*	*Women*
Illness of employee	269	345	74 3	70 3
Illness or death in the family	30	61	8 3	12 4
Transportation difficulties—				
Car trouble	26	24	7 1	4 9
Driver	8	9	2 3	1 7
Tire trouble	2	5	5	1 1
Other	7	7	2 0	1 4
Auto accidents	2	8	5	1 6
Military reasons	5	0	1 4	0
Employees needing care for children	0	8	0	1 6
Miscellaneous	13	24	3 3	4 9
TOTAL REPORTS	362	491	100%	100%

Employee transportation today constitutes one of greatest factors in absenteeism—often being the second highest cause. From all indications, it will continue a tough nut to crack.

Trail Blazing in the Skies

1920

THE FIRST BULLET-PUNCTURE-SEALING GASOLINE TANK for military airplanes was developed by Goodyear at the close of World War I. After exhaustive tests it was adopted by the Army Air Corps and Goodyear was officially commended in 1920 for its invention. That is a matter of record, as was its effectiveness in sealing punctures made by the small-calibe armament then carried by planes.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AVIATION INDUSTRY

1. *By building parts to manufacturers' specifications.*

2. *By designing parts for all types of planes.*

3. *By re-engineering parts for mass production.*

4. *By extending our research facilities to aid the solution of any design or construction problem.*

1943

AS A RESULT OF THIS EXPERIENCE, Goodyear is today building bullet-puncture-sealing tanks that self-close punctures made by modern heavy-caliber ammunition which rips jagged, flaring holes in ordinary metal tanks. So swift is this sealing action, very little gas is lost and the danger of fire from incendiary bullets is greatly reduced. Goodyear supplies all types and sizes of these tanks to fit the varying needs of both fighter and bomber planes.

THE IDEAL BEARING FOR HEAVY DUTY CONTROLS

The Timken Bearing has tremendous load carrying ability by virtue of line contact of rolls and races and the use of Timken Steel. Moreover, the Timken Bearing is a *tapered roller bearing* which means it can carry radial loads, thrust loads or both together in any combination—all within the bearing.

Where alignment is a factor in control mechanisms Timken Bearings have another point in their favor for they hold shafts, wheels, pulleys in constant alignment. Moveover, the design of the Timken Bearing permits the achievement of any desired degree of tension wherever they are used.

Look over your present designs of heavy duty control to see where Timken Bearings can be used to advantage. Keep the advantages of Timken Bearings in mind along with those designs you have in the back of you head but not yet on paper which will be incorporated in planes of the future. A wide range of sizes are available for your selection.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

"All There Is In Bearings"

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

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Manufacturing Section of AVIATION

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Consolidated Celebrates its 20th Anniversary 122

Single Assembly Line Produces Both Bombers and Transports
R. C. Sebold and S. J. Powell 126

Modification Centers—An American Military Innovation
Glenn Hotchkiss 134

Points On Plastics in Aircraft Engineering, I ..... *John Sasso* 141

Aircraft Tool Planning, I ..... *Richard H. Luders* 144

Airflow Visualization Opens New Avenues of Research .. *Erwin J. Saxl* 148

Photoprint Process of Loft Layout Reproduction .. *Frank B. Marshall* 154

Design Considerations of Plywood Structures, IV .... *L. J. Marhoefer* 164

Theory and Technique of Perspective Projection, III .. *George F. Bush* 171

Report of 38th SAE Meeting 177

Factory Maintenance Section: Proper Care of Compressed Air Plants
Ed C. Powers 179

Review of Patents ..... *A. Harry Crowell* 192

Subcontractors Section:
Consolidated Subcontract System Coordinates Schedules ..... *Howard G. Golem* 195

Aviation's Sketch Book of Design Detail
Aeronca TG-5 Landing Gear—Assembly Breakdown and Details 183

Boeing B-17F *Flying Fortress* Dorsal Fin 183
Cutaway of Interstate L-6 185
Diagrammatic Layout of Two-Stage Supercharger on Rolls Royce *Merlin* 61 187
Bristol Hydraulically Operated Power Gun Turret 187

Aviation's Engineering Data Book
Aircraft Steel Tubing—Specifications and Purchasing Instructions 189

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The Timken Bearing has tremendous load carrying ability by virtue of line contact of rolls and races and the use of Timken Steel. Moreover, the Timken Bearing is a tapered roller bearing which means it can carry radial loads, thrust loads or both together in any combination—all within the bearing.

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Look over your present designs of heavy duty control to see where Timken Bearings can be used to advantage. Keep the advantages of Timken Bearings in mind along with those designs you have in the back of you head but not yet on paper which will be incorporated in planes of the future. A wide range of sizes are available for your selection.

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Manufacturing Section of AVIATION

PRODUCTION • DESIGN • RESEARCH • ENGINEERING

Consolidated Celebrates its 20th Anniversary 122

Single Assembly Line Produces Both Bombers and Transports
R. C. Sebold and S. L. Powell 126

Modification Centers—An American Military Innovation
Glenn Hutchinson 132

Points On Plastics in Aircraft Engineering, I 136

Aircraft Tool Planning, I ..... *Richard H. Lathers* 140

Airflow Visualization Opens New Avenues of Research ..... *Erwin J. Saul* 148

Photoprint Process of Loft Layout Reproduction ..... *Frank B. Marshall* 154

Design Considerations of Plywood Structures, IV ..... *L. J. Markwardt* 158

Theory and Technique of Perspective Projection, III ..... *George F. Kuhl* 171

Report of 38th SAE Meeting 176

Factory Maintenance Section: Proper Care of Compressed Air Tools ..... *Ed. Co. Pearson* 177

Review of Patents ..... *A. Harry Crowell* 192

Subcontractors Section:
Consolidated Subcontract System Coordinates Schedules ..... *Howard G. Golem* 195

Aviation's Sketch Book of Design Detail
Aeroseo TG-5 Landing Gear—Assembly Breakdown and Details 183

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PRODUCTION • DESIGN • RESEARCH • ENGINEERING

Consolidated Celebrates its 20th Anniversary 122

Single Assembly Line Produces Both Bombers and Transports
R. C. Sebold and S. J. Powell 126

Modification Centers—An American Military Innovation
Glenn Hotchkiss 134

Points On Plastics in Aircraft Engineering, I ..... *John Sasso* 141

Aircraft Tool Planning, I ..... *Richard H. Luders* 144

Airflow Visualization Opens New Avenues of Research .. *Erwin J. Saxl* 148

Photoprint Process of Loft Layout Reproduction .. *Frank B. Marshall* 154

Design Considerations of Plywood Structures, IV .... *L. J. Marhoefer* 164

Theory and Technique of Perspective Projection, III .. *George F. Bush* 171

Report of 38th SAE Meeting 177

Factory Maintenance Section: Proper Care of Compressed Air Plants
Ed C. Powers 179

Review of Patents ..... *A. Harry Crowell* 192

Subcontractors Section:
Consolidated Subcontract System Coordinates Schedules ..... *Howard G. Golem* 195

Aviation's Sketch Book of Design Detail
Aeronca TG-5 Landing Gear—Assembly Breakdown and Details 183

Boeing B-17F *Flying Fortress* Dorsal Fin 183
Cutaway of Interstate L-6 185
Diagrammatic Layout of Two-Stage Supercharger on Rolls Royce *Merlin* 61 187
Bristol Hydraulically Operated Power Gun Turret 187

Aviation's Engineering Data Book
Aircraft Steel Tubing—Specifications and Purchasing Instructions 189

Consolidated Celebrates Its 20th Anniversary

In the 20 years of this company's development it has gained experience with nearly every type of airplane. Here is the history of its growth and of the aircraft produced from 1923 to the present time.

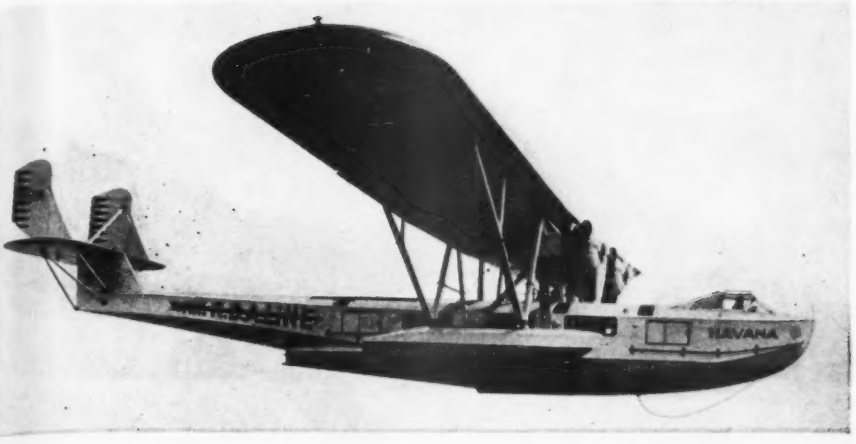
THIS YEAR marks the 20th anniversary of Consolidated Aircraft Corp. Known all over the world today as one of the leading makers of large airplanes, this company was formed in 1923 by Maj. Reuben H. Fleet in Greenwich, R. I. At that time, it shared quarters with the Gallaudet Aircraft Corp., and its first order was for 20 training planes! Now joined with Vultee, it becomes one of the largest aircraft companies in the world.

Organized 20 years ago this month Maj. Reuben H. Fleet in Greenwich, R. Consolidated Aircraft moved, the follow year, to Buffalo, where training planes built. This was the plant size after four ye

In 1941, an important develop took place which contributed much Consolidated's present position. Vu Aircraft acquired 34 percent of C solidated's outstanding common sto which brought to a company alre highly regarded for its products managerial experience that pione

It would be lost in any one of Consolidated's plants today, but in 1925 this was the company's complete machine shop, including sheet metal operations shown in background. Primary trainers were the product.

The PT-3, produced in considerable numbers in the Buffalo plant from 1924 to 1929. Powered by Wright J-5's, they were strong reliable craft.



In 1928 Consolidated began work on large flying boats under direction of I. M. Laddon, now executive vice-president and general manager. First developed was the *Admiral* for the Navy, a modification being the *Commodore* (shown above) a 32-passenger craft used by NYRBA over what was then the world's longest airline, running 15,000 mi. from U. S. to Buenos Aires, touching 15 countries.

With this Fleet two-place biplane, Consolidated entered the commercial production field in 1929, selling some 600.

uccessful methods in producing steel t Republic and smaller aircraft at ultee.

Since Vultee previously had made mall planes for civilian use, and now akes basic trainers, observation planes, ghters, and dive bombers, while Consolidated has long specialized in heavy ombers and large ships, the two firms omplement each other in product and xperience.

Company Development

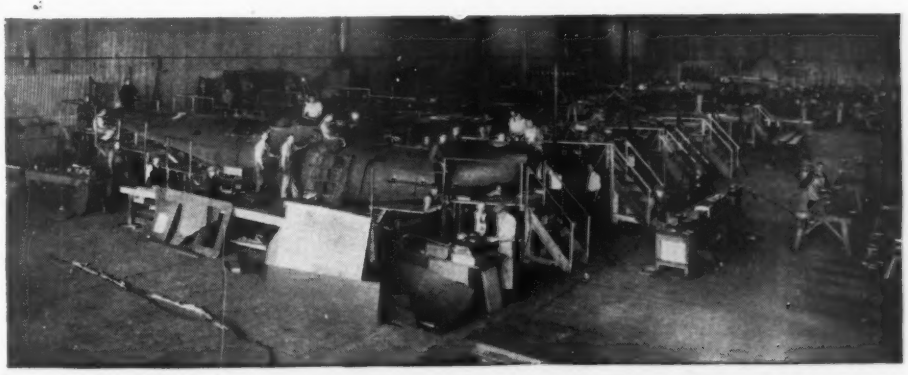
Consolidated's first order was for 20 wo-place side-by-side training planes f Dayton-Wright design for the Army ir Corps. Following this the company produced training ships of its wn design, which brought about a need or larger quarters. In 1924 it moved o Buffalo, N. Y., where it occupied the ld wartime plant of Curtiss.

From 1924 to 1929 it produced hundreds of primary trainers, the PT-3's or both Army and Navy. These were imple, rugged craft, powered by Wright J-5 engines, which did admirable ervice with new standards of safety, in urning out flyers.

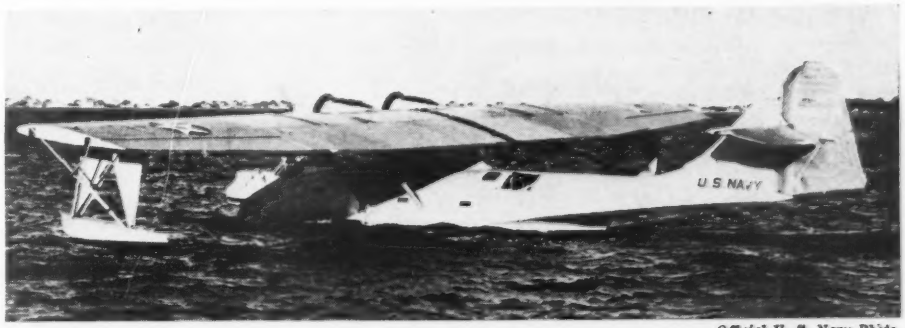
In 1929 the company made its first ntry into the commercial field on a roduction basis, with the sale and delivery of about 600 *Fleet* two-seater iplanes, which measured 28 ft. in span nd were powered by 60- to 200-hp. ngines.

Even more important to the company's future was the beginning, in 928, of specilization on flying boats f advanced design, under direction of esigner I. M. Laddon. This policy has ade the company known as a leader this field.

First of these flying boats was the *dmiral*, built for the Navy in 1928. It ad a span of 100 ft. and was the first



Production line, 1932 model, for building P2Y's on an order of 24 for the Navy. Note semi-permanent "cradles" for hulls, a construction method still extensively used eleven years later.

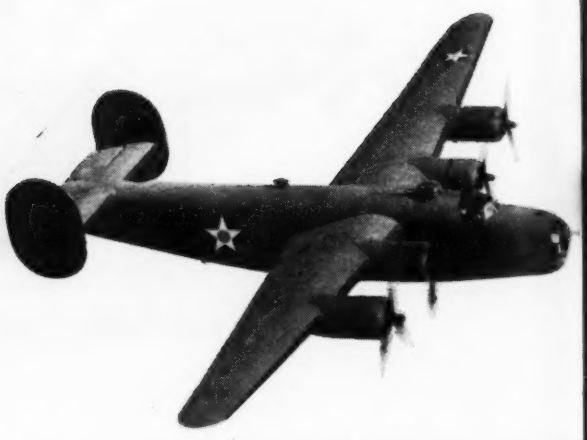


Official U. S. Navy Photo

Prototype of the *Catalinas*, the XP3Y. In 1934 the Navy flew six of these in formation, non-stop, from San Francisco to Honolulu. Twenty-three were sold to the Navy.

Two-place Army attack plane, one of 50 delivered in 1935 on the first order from the San Diego plant. Note the turbo-supercharger mounted outside.

Plans for the prototype of the PB2Y *Coronado* were drawn up in 1936. It is now the largest plane in production at Consolidated, and embodies the knowledge of long experience in this field.



One of the crowning achievements of Consolidated's development of large planes is the B-34 *Liberator.* Research on this design was started in 1938. It holds the Atlantic crossing record of 6 hr. 40 min.

large monoplane flying boat produced in America up to that time. A modification of this design was the *Commodore,* which had a maximum capacity of 32 passengers. By 1930 these ships were being operated in South American service over what was then the world's longest airline, extending 9,000 mi. through 15 countries. This route was later absorbed by Pan American to become the latter company's South American east-coast run.

Following the *Commodore* came the P2Y design, 100 ft. in span and 62 ft. long, of which 24 were sold to the Navy. In January of 1934 the Navy showed the value of this type by flying six P2Y-1's in formation from San Francisco to Honolulu—the first 2,414-mi. non-stop formation-flying flight—which opened a new field to Naval operations. Twenty-three more ships, of the general P2Y-2 and -3 type, were also delivered to the Navy.

As a natural consequence of flying boat development and the attendant need for ice-free water the year 'round, Consolidated moved from Buffalo to San Diego, Calif. in 1935, where constant research and experiment were possible.

The first order completed here was a lot of 50 two-place attack planes f the Army, which are of considerab interest now because of the early appl cation of a turbo-supercharger. A thr blade propeller was also new on single-engine ship.

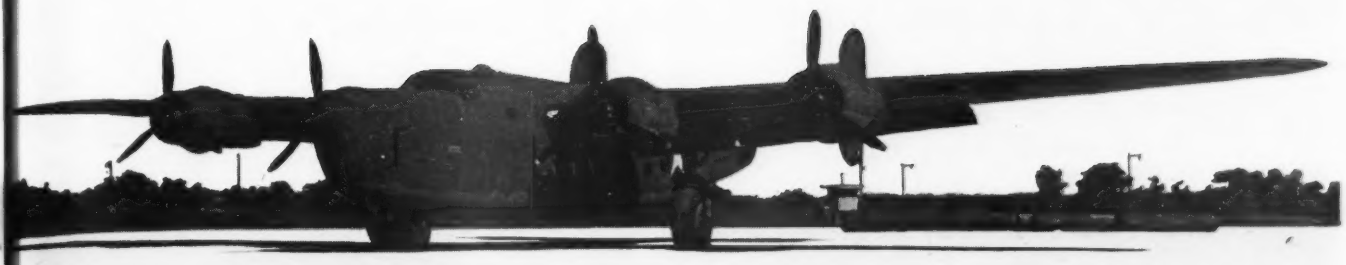
It was in San Diego that the Nav placed first orders for PBY twin-engi flying boats, which have now built u an unforgettable history in this war a the *Catalina* patrol bombers. After de livery of the first PBY, this type pile up many records, including non-sto group flights from San Diego to Pan ama and Hawaii, Sir Hubert Wilkin 19,000-mi. trip in the Arctic search fo the lost Russian flyers, and Richar Archbold's *Guba* in the first equatoria globe circling flight by a seaplane. Th pilot on this last trip was Russel Roger who is now Consolidated's flight an service manager, commanding the pilot who fly Consolidated ships to man regions under the United Nations.

In 1936 came the design of the four- engine XP2Y-1 flying boat, which wa the forerunner of the present PB2Y *Coronado.* This is now the larges Consolidated plane in production, a well as the largest and most powerfu in service with the Navy.

Research begun in 1938 on the de sign of a large land-based bomber at tracted the attention of the Army i 1939, resulting in the now famous B-24 *Liberator,* which among many other achievements, holds a 6 hr. 40 min record for crossing the Atlantic. As the C-87, with a reinforced frame and with out turrets, the same plane carries six ton loads more than 3,000 mi., and holds the Pacific crossing record, having flown from Australia to San Francisco in under 36 hr.

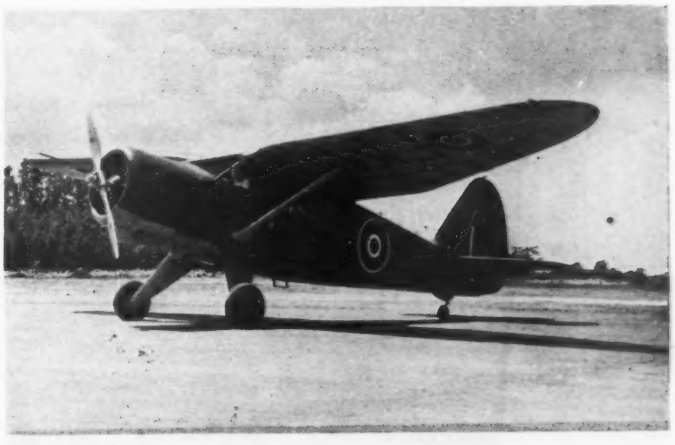
With the addition of the Vultee lin

Ninety (count 'em) Vultee BT-13's. This craft is now one of the large Consolidated family. Quite a jump from the PT-3. Basic trainers were Army's largest order ever placed on one type of plane.



The C-87, converted to transport service from the B-24, is one of the largest load carriers. This version is turned off the same line, on order, as the B-24. It has flown from Australia to San Francisco in less than 36 hr.

The Vultee-Stinson *Sentinel*, now used by the Army for observation and liaison. With the addition of Vultee Aircraft, Consolidated covers a wide range from this to the PB2Y.



Familiar to civilian users is the Vultee-Stinson *Reliant*, which has been assigned to British navigation training. This adds another type to Consolidated's varied production.

f planes, the Consolidated family be-omes a large one, covering nearly every ype. The original Consolidated group ow consists of four types, comprising some of the largest and most important aircraft in service.

First is the old reliable *Catalina*, one of the oldest in active operation. In the far flung bloody battles of the Pacific, those who know credit this ship with a winning part solely for persevering

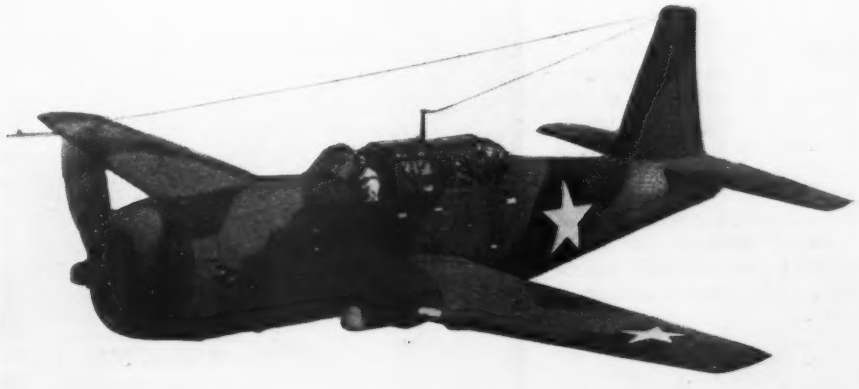
(*Turn to page* 404)

• Consolidated Aircraft Corp. completes its 20th year and merges with Vultee to form the Consolidated Vultee Aircraft Corp.—a milestone in aviation history.

Following this article on the growth of Consolidated is a description of the company's most spectacular war production effort—turning out the mighty B-24 *Liberator* bombers and the conversion cargo carrier, the C-87 *Liberator Express* from the same assembly line in Texas.

The final phase in production is modification of assembly line aircraft to accommodate the most up-to-date design changes. Consolidated's important modification center in Arizona is described on page 134.

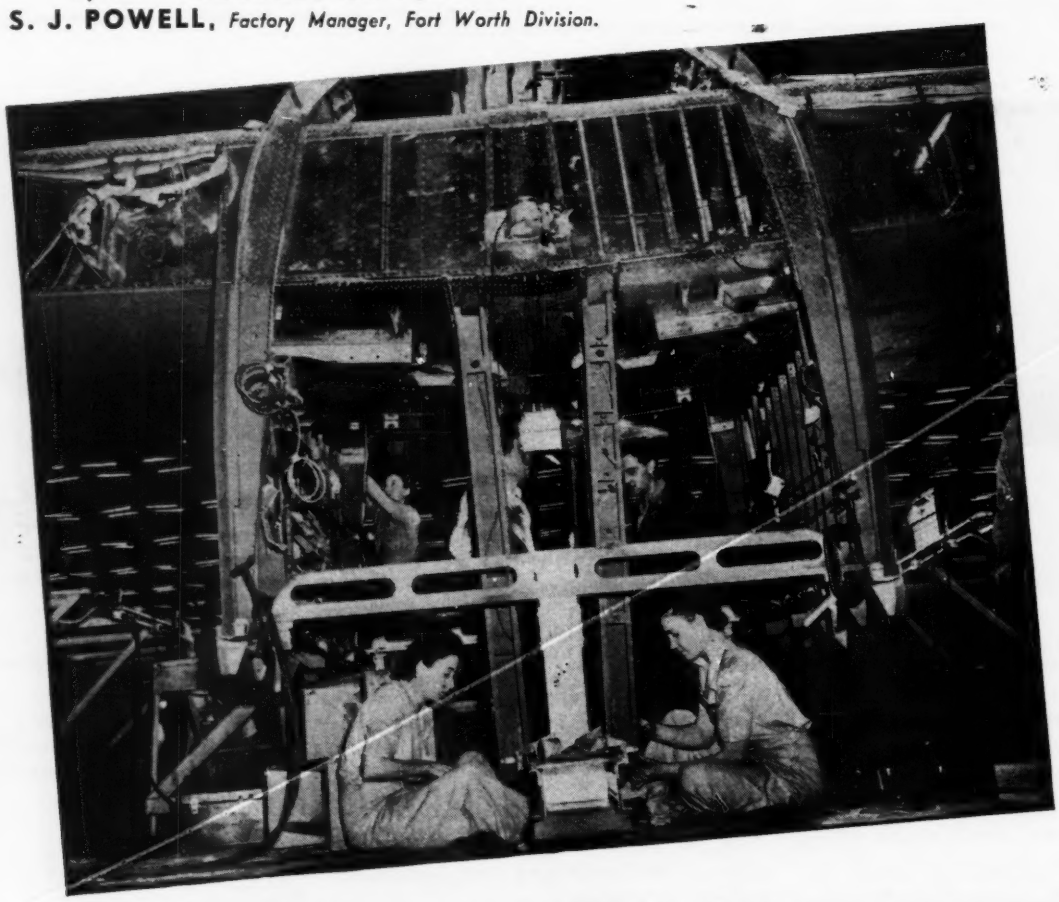
To round out the picture of a major aircraft producer in operation, there is an article on how Consolidated has established a distinctive subcontracting system to insure a steady flow of parts for the assembly lines (page 195).

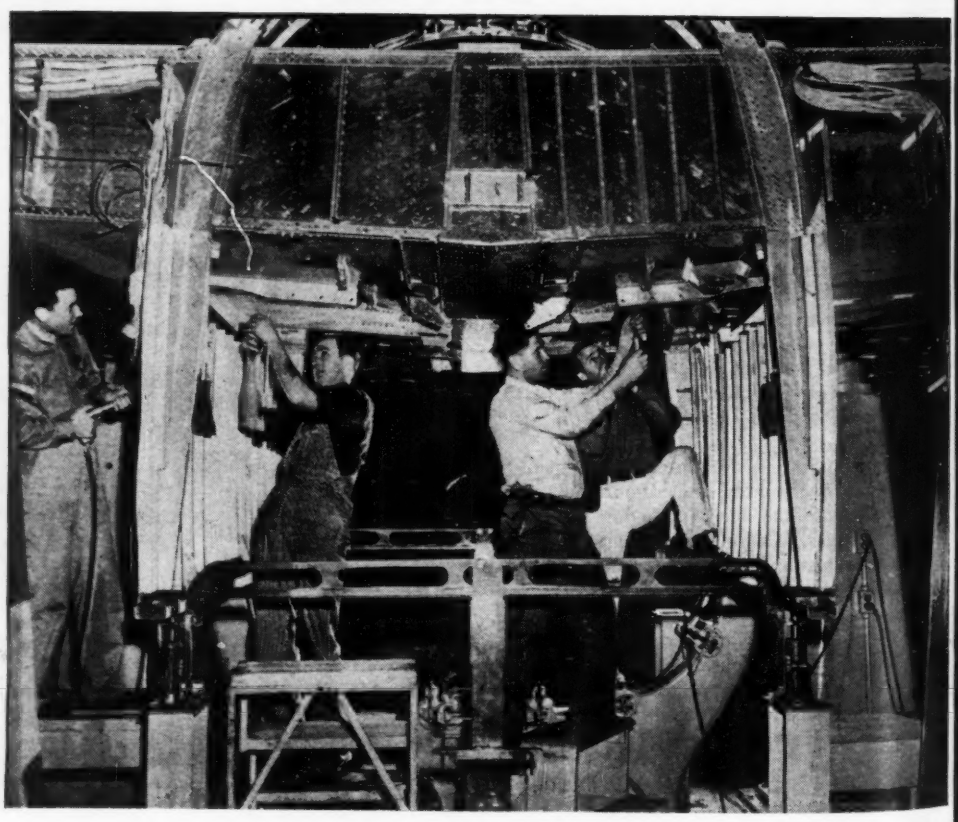


A capable dive bomber, the Vultee *Vengeance* is also used by the British. It can be held to a low diving speed and is said to be unusually steady. It completes the Consolidated group.

Single Assembly Line Produces Both Bombers and Transports

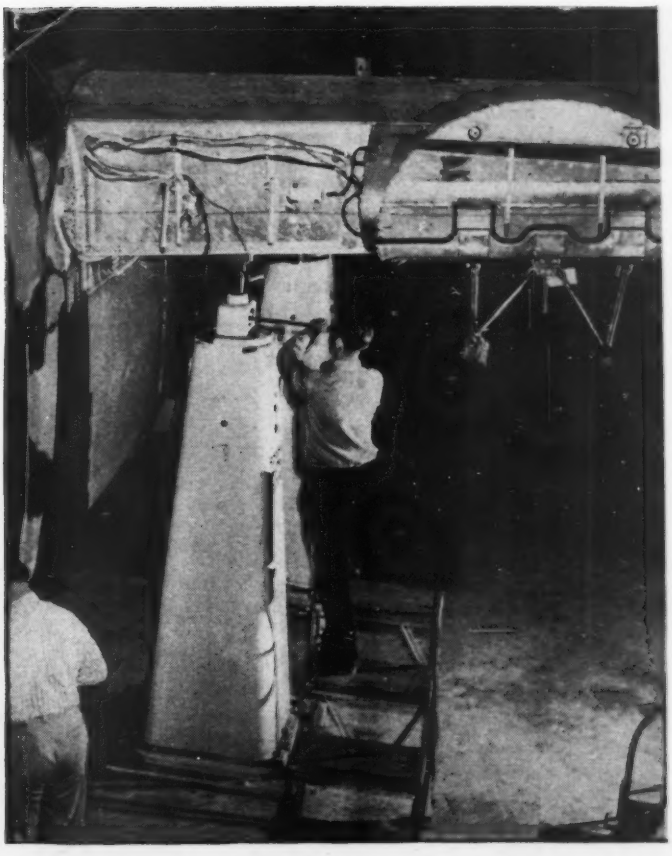
By **R. C. SEBOLD**, *Chief Engineer, and*
S. J. POWELL, *Factory Manager, Fort Worth Division.*





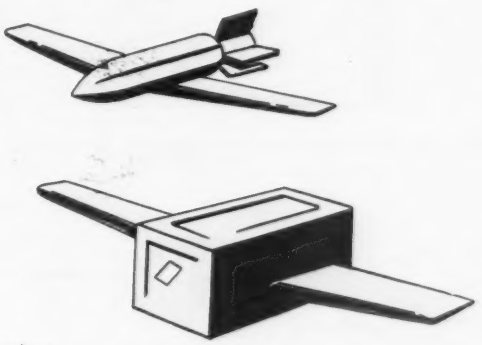
One will be a *Liberator* bomber, the other a *Liberator Express* cargo plane. Above, Consolidated workers attach side panels, bomb racks, and cat walk to wing center section, key subassembly. Note T-shaped stretcher bar in foreground, holding side panels in place and locating cat walk seen at bottom of bar. Right, side panels of cargo version are attached in bomb bay mating jig. Also note absence of bomb racks and cat walk but second use of T-shaped stretcher bar (foreground) to hold side panels rigid while windows are cut.

Close-up of screw jacks supporting wing center section in fuselage mating fixture for producing both bombers and cargo planes. Note arrangement of electric outlets on sides of jacks.



One of two pairs of screw jacks which support wing center section while nose and tail fuselage sections are added in fuselage mating fixture.

Design and production coordination at Consolidated's Texas plant turns out both B-24 "Liberator" bombers or C-87 "Liberator Express" cargo-transports without cutting production rate. Most changes are made on final assembly line.



A MINOR CYCLONE hit Consolidated Aircraft Corp.'s Texas plant when the Army Air Forces sent through a rush order for conversion of B-24 *Liberator* bombers into transports.

The *Liberator* had already won a name for itself as an adaptable transport in the hectic days of the evacuation of Java, when it soon became known that vital personnel and important cargo could be carried in the roomy fuselage and with additional cargo packed in the racks where bombs once had gone. Other bombers available couldn't be adapted as sorely-needed cargo carriers to move big loads great distances as easily as could the B-24, so while the former gained bombs on advancing Japs, the *Liberators* shuttled virtually unsung in the background. But they brought out the sorely needed equipment and invaluable men that are fighting again.

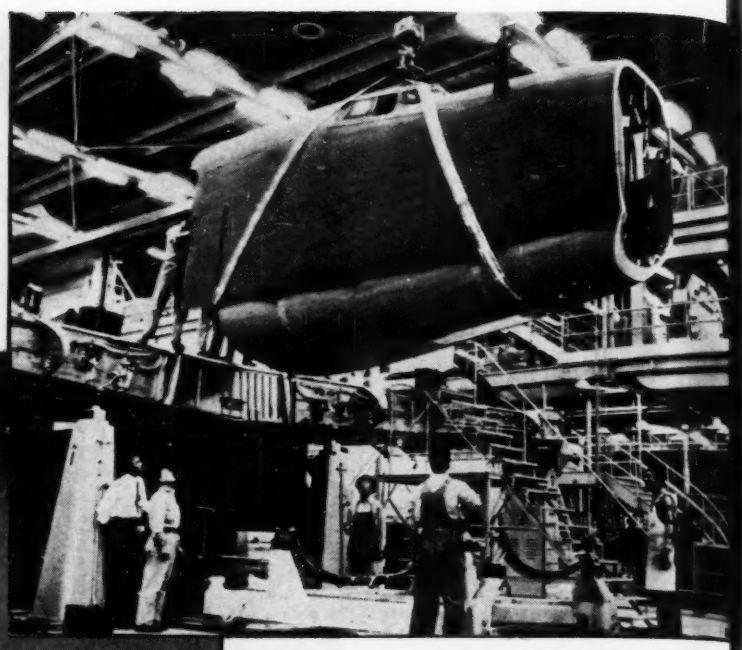
The immediate necessity for moving cargos up out of reach of submarines' ship-sinking torpedoes brought Consolidated a hurry-up order to really make transports out of its bombers—transports that can carry over six tons more than 3,000 mi., at speeds in excess of 300 mph., a combination feat unmatched by any airplane now in mass production.

One of the first C-87's—the Army designation for the cargo version—off the longest mechanized straight production line in the aircraft industry carried Wendell Willkie and a party of high officials on their globe-circling mission and became the first American plane to fly over the treacherous expanses of the Gobi Desert as well as the first to fly from China to the United States via Alaska during wartime. Another brought decorations to Lt. Gen. H. H. Arnold and to the crew by setting a 44-hr. flying time record from Brisbane, Australia, to Washington, D. C. Including stop-overs, the entire trip took only 77 hr., 5 min.

From the outside there is little difference between the B-24 and the transport. The bomb bay has been refaired and replaced with a belly covering, the bombardier's compartment in the nose has been closed in, with a door installed to permit loading of cargo in the space. The tail gun turret has been rearranged by adding a door through which long airplane parts, such as wing flaps, ailerons, and stringers, can be put endwise into the ship, and a 6-ft. square cargo door was cut into the tail fuselage.

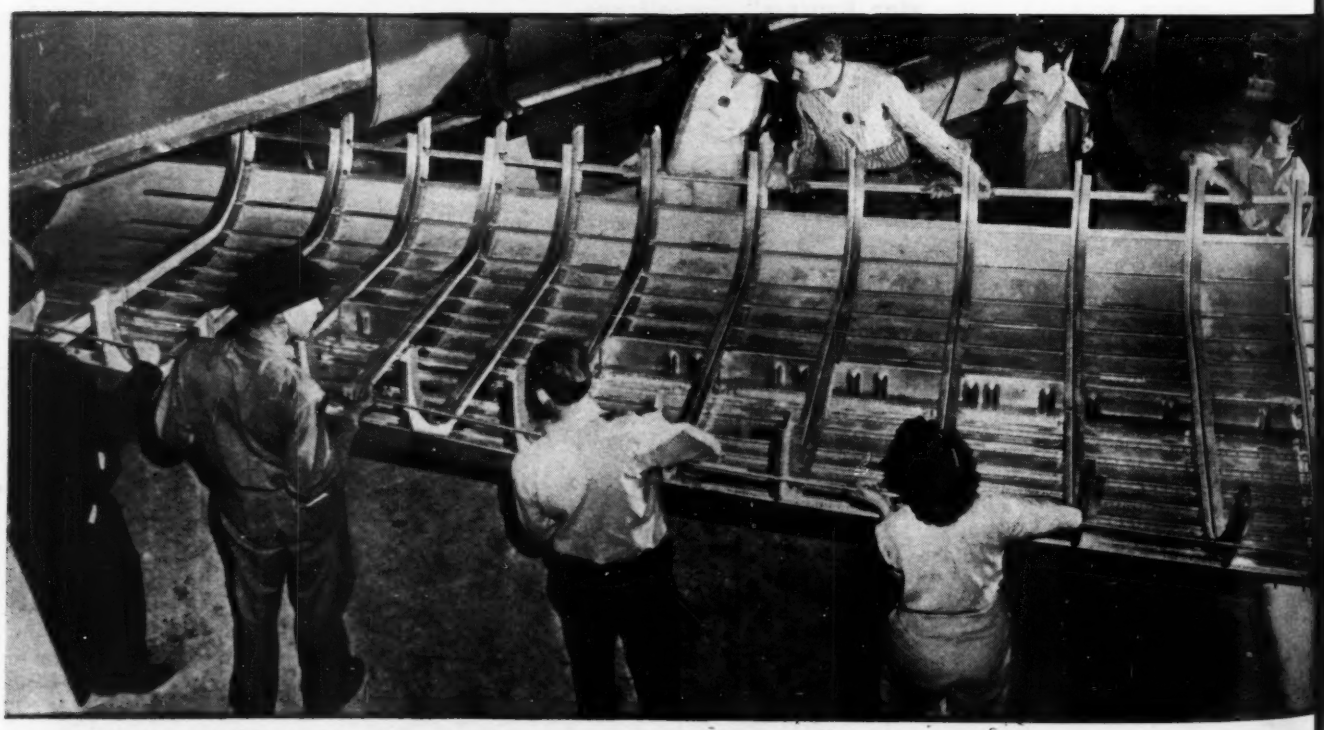
But, while the lines were little changed, the conversion involved a tremendous amount of engineering, calling on the

Nose fuselage section is lowered by overhead crane into dolly on which it will be rolled back for attaching to wing center section and side panels. In this bomber version, bomb bay catwalk with extended splice plates will serve as one of tie-ins between sections. Below, close-up of nose section being lowered onto dolly. Bomb bay catwalk, which acts as tie-in, can be seen just beneath worker's arms. In cargo version, T-shaped stretcher bar would still be in place as tie-in and locating guide between sections.

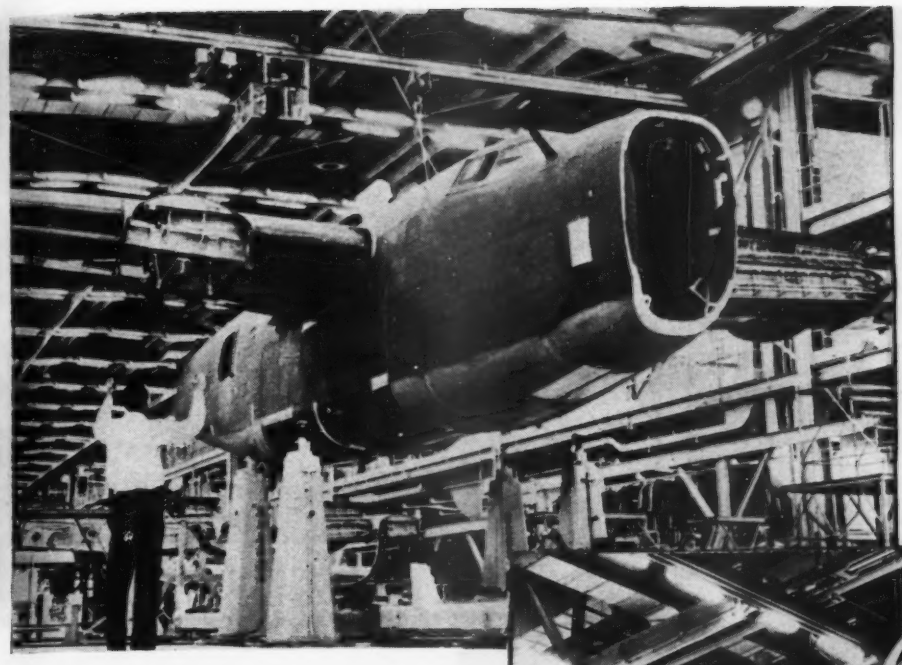


ingenuity of Consolidated design en
neers as well as assembly line exper
Adding to the difficulty was the nec
sity of tooling production so that b
bomber and transport could be built
the same line.

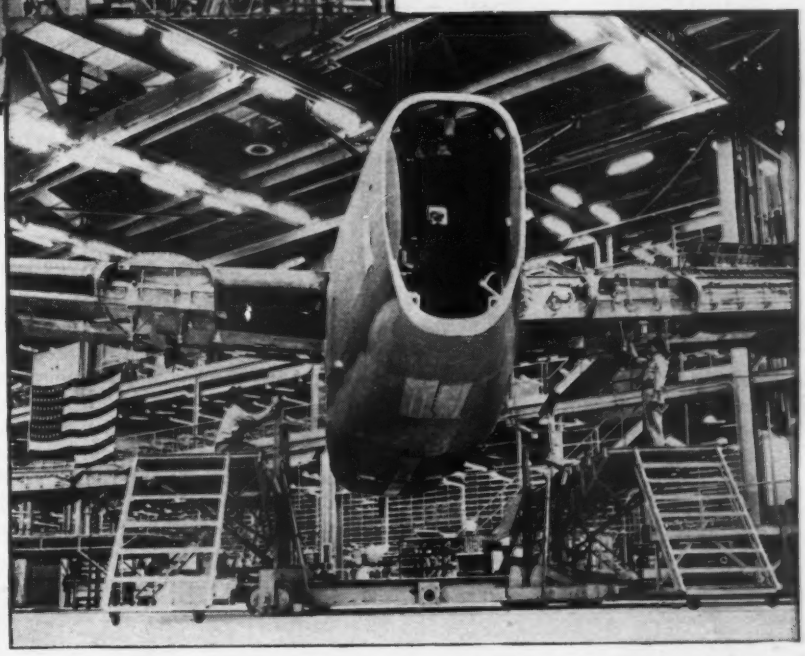
In Consolidated's production set-
the center section of the plane's 110-
wing spread is the key subassembly.
moves from the wing bucks to the bo
bay mating jigs where bomb bay c
walk, side panels, and bomb racks a
riveted together. Farther down the li
this center structure goes into the fu
lage mating fixture, where nose and t



With nose and tail fuselage sections mated to center section, wooden stand is placed under aft end of tail for support and a wheeled cradle is rolled out to give clearance for installation of faired belly section. Here, employees move belly, which has been built as separate subassembly, into place to cover bomb bay opening, one step in converting B-24 into C-87.



Left, after nose and tail fuselage sections have been mated to wing center section, ship is lifted from mating fixture by overhead monorail cranes for removal to final assembly line. Below, bomber brought from mating fixture is lowered into final assembly line cradle at Texas plant. Tie bars between each carriage move entire line along with planes at 45-deg. angle to direction of travel. Next plane might be cargo version, but speed of travel of line would remain the same.



fuselage sections are added. From the mating fixture the plane is lifted to the final assembly line and conveyors pull it through station after station while workmen add inside installations, outer wing panels, motors, propellers—everything needed to make it a finished ship.

Legion were the design problems involved in achieving this flexibility, which met requirements for both bomber and transport and brought two production records to the Texas plant.

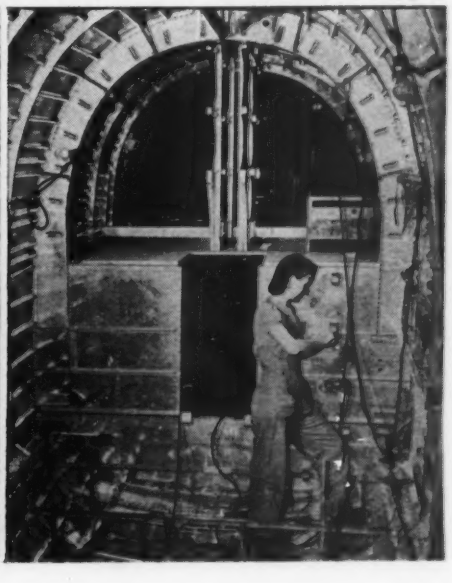
One was substitution of the refaired belly section for bomb bay doors, bomb racks, and cat-walk. Attempts first were made to fit the belly into the bomb bay mating fixture and rivet it to the side panels assembled there to the wing center section. But the arrangement proved unsatisfactory, so the wing now comes to the bomb bay fixture and picks up side panels and a "stretcher" bar, the arms of which reach between the side panels to hold them rigidly in place while window openings are cut.

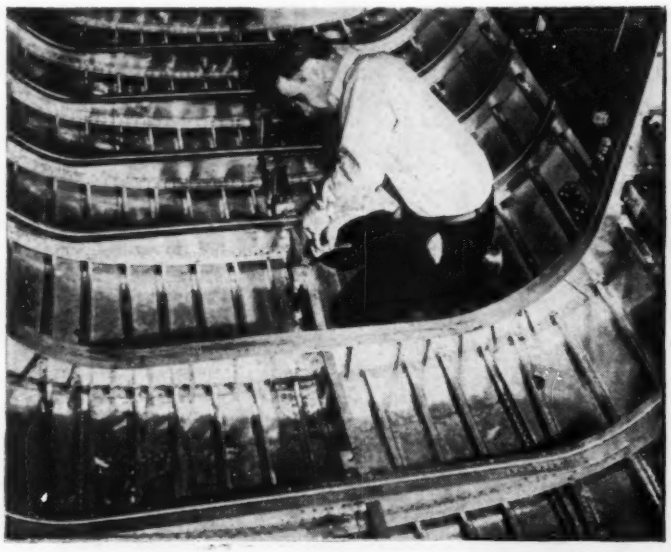
When this assembly reaches the fuselage mating fixture, giant jacks support the wing center section and the nose and tail fuselage sections are brought by overhead crane to wheeled cradles which move them into the mating fixture. Here a locating bar jig, stretching from nose to tail fuselage sections, is slipped in as a means of alignment. It substitutes for the cat-walk which serves a similar purpose in the mating of the bomber components.

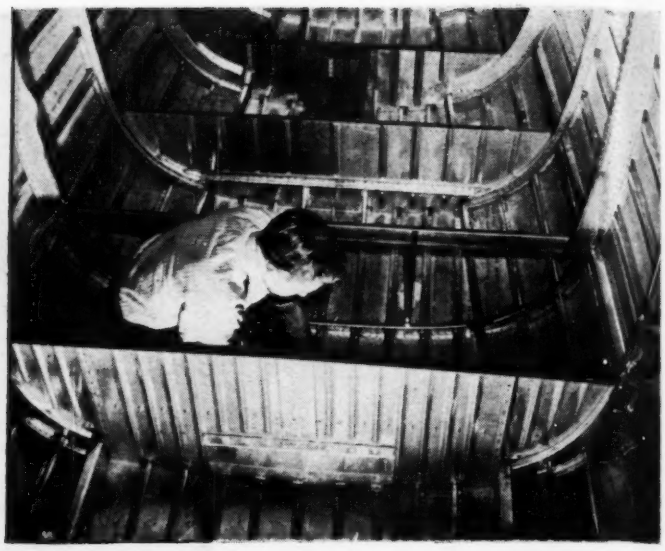
Nose and tail are then riveted to the wing center section and the locating jig and stretcher bar is removed. A wooden stand is put beneath the aft end of the tail for support and the wheeled cradle is rolled backwards out of the way to give clearance for insertion of the belly.

Built on separate jigs and a unit in itself, this section covers the gaping maw of the *Liberator's* long bomb bays and

Below, while outward appearance of B-24 bomber and C-87 cargo-transport is much the same, necessary design changes run into hundreds. Bulkheads beside which these Consolidated workers stand are at same station in both versions. Note in transport version (left) how bulkhead has been strengthened. In bomber, right, portion of this bulkhead extends to provide enclosure around bomb bays. Narrow opening in center will, in finished plane, give access to cat walk between bomb racks.







Floor structural differences in fuselages of *Liberator* bomber and *Liberator Express* are shown here. In cargo version (left) workman installs tie-down bracket along strengthened floor bracing. Note difference in floor levels and "beefed up" bulkheads compared with bomber (right). Changes were made to handle different load distributions.

when it reaches the mating jig, lacks only trimming of skin and stringers of being a completely finished unit. Once slipped in place, overlapping skin and belt frame are cut to proper alignment and riveted in position. Splice plates are riveted and bolted and the ship is ready for lifting out of the mating fixture.

Structural changes in the C-87 necessary to carry heavy cargo loads are made almost entirely in the tail fuselage section. Bulkheads are "beefed up" and bell frames and flooring supports added. But the major conversion changes involve putting in the 6-ft.-square cargo door—big enough to permit loading of complete engines and huge packing crates.

From one of the bulkheads which is reinforced to take most of the load of the aft end belly tie-in, to a bulkhead on the empennage side of the cargo door, strengthening sections are added. A longeron is inserted in place of stringers at the top and bottom of the door and a heavier reinforcing skin riveted all around the opening and extended underneath the fuselage.

Sills, hinges, and finishing strips complete the opening and ready it for the door, which is added along the final assembly line.

While the plane is still in the fuselage

Below, addition of extra bulkhead is necessary in cargo transport to give strength for 6-ft. cargo opening. Left, woman worker fastens lift-a-dot studs on new bulkhead. Just above and to right of her hands is belt frame (part of it cut away in making cargo door opening) which is same point in the ship as belt frame being drilled in bomber version by man (right).

mating jig, the remaining windows are located and cut. Three of the seven on each side are included in the side panel which is attached to the wing center section in the bomb bay mating fixture and have been cut before the assembly reaches the fuselage tie-in operation. The other four are cut a step or so previous to addition of the belly.

A steel template is fitted to the longeron at the bottom edge of the side panel and the remaining windows scribed. All seven are about 12 in. high and 18 in. wide and are located about 2 ft. apart. They reach from just beneath the wing along the length of the ship toward the cargo door.

When the scribing has been completed, the template is removed and cutting-out of the window begins. First, skin rivets are drilled out, then the opening cut with machine reamers. Interfering stringer portions are sawed away and reinforcing headers put in. A window sill is added on the inboard side and beveled-edge window patches riveted on the outboard side. Final assembly stations complete the fairing with Plexiglas windows.

In converting the bomber, each change brought others. Putting in windows, for example, necessitates complete re-routing of the surface control cables as well as changes in the intercommunication lines and electrical wiring.

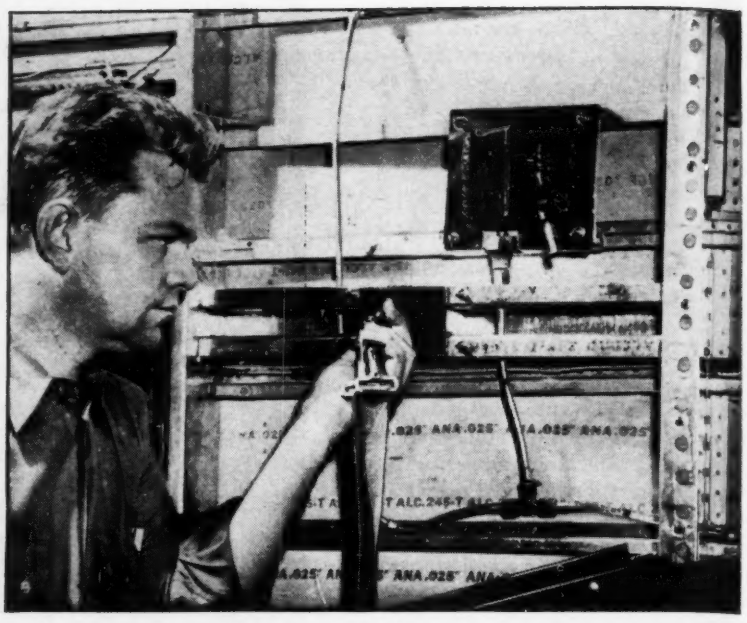
Most of these cables are lowered and run beneath the window level. Putting them there brought them into the cargo area, so compressed fiber wood panel-

Installation of 6-ft. cargo door to permit loading of complete engines necessitated some major design changes. Strengthening sections are added to fuselage from stations ahead to empennage side. Longeron is inserted in place of stringers at top and bottom of door and heavier reinforcing skin is riveted around opening and extended underneath fuselage. Installation of door itself takes place at later station on final assembly line.

Above, strengthening skin patches are riveted around window openings in fuselage of *Liberator Express* transport.

Left, re-routing of control cables and wiring required in cargo version necessitates addition of aluminum control line covers (at top) and compressed fiber wood paneling (below window). Note sound-proofing beneath paneling in lower left hand corner.

Installation of sound-proofing and interior trim of transport version. Lift-a-dot fasteners facilitate both installation and removal of covering insulation for access to equipment.



Close-up of cargo tie-down brackets attached to strengthened braces between bell frames, one of hundreds of design and production changes required in bomber-to-cargo conversion. Most of them are made on final assembly line.

ing has been added as a protective covering. These panel sections are soaked in hot water tanks in the anodizing department, formed, and dried. Then they are attached with rivets and bolts to the inboard edge of fuselage bulkheads.

Since the paneling extends only to the window levels, in places where the cables have to be routed higher—above the cargo door opening, for instance—special dural guard plates and covering must be installed.

Another change was required by the cargo tie-down brackets to provide lashing points, and these, in turn, called for reinforcing of bulkheads at those stations. Still another problem was provision of heat for the transport pas-

Design and production changes necessary to roll bombers and cargo transports from same assembly line run from nose to tail. These detail photos show how tail gunner's turret is re-arranged and glass door installed through which long aircraft parts, such as flaps, or stringers, can be loaded. On cargo version, bombardier's compartment is replaced by 18-in. fuselage extension and cup-shaped cargo door, with bulkheads and floor supports strengthened and paneling and insulating trim installed.

sengers and jiffy-removable seats so that the plane could carry cargo as well as men. Ducts from the heater are run along the sides of the C-87 at floor level —and that made it necessary to shorten the seat legs on the outboard sides.

Then the reservoir for the hydraulic system which operates wing flaps and landing gear had to be shifted from the bomb bay area, where it had been in the *Liberator* bomber, to the flight deck compartment in order that it would not clutter up valuable cargo space.

Other changes moved the navigator and his table from what had been the bombardier's compartment up to the flight deck. This caused a shifting of the radio operator's position. And the astrodome, which had been above the navigator in the nose, was moved back

Relocation of oxygen tank racks and installation of lines to outlets by each seat are other innovations in the transport, as is the canvas and Kapok soundproofing and finishing trim which lines the interior of the fuselage. The trim is

(*Turn to page* 403)

Final clean-up of *Liberator Express* by Consolidated's Yard and Flight Department. Seats—with specially shortened outboard legs to accommodate heat ducts—are easily removed with jiffy-action fasteners in floor so that cargo as well as personnel can be carried.

Finished Product

Consolidated C-87 *Liberator Express* gets engine run preparatory to test flight. Design and production ingenuity mean that ships just ahead and behind on assembly line could have been either bombers or cargo-transports without cutting production rate.

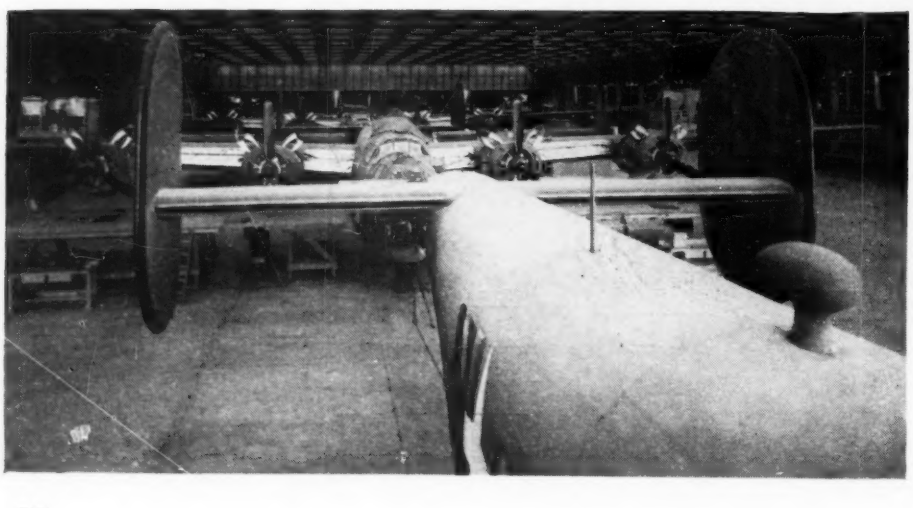
Upon fly-in arrival at the modification center field, planes are prepared for entry to this line by having fuel, alcohol, and oil pumped from their tanks, removable equipment stored, and a towing device attached to nose wheel axle. Door in background is opened to admit a plane.

Modification Centers ... An American Military Innovation

By **GLENN HOTCHKISS**

Works Manager, Consolidated Aircraft Modification Center.

Modification centers relieve back pressure built up on quantity production lines in form of engineering change orders made in light of combat experience. Consolidated center described here is typical of dozens of quickly built plants where "airplane tailors" are making parts and equipment with make-shift tools, to give our airmen "Tomorrow's Fighting Planes Today".



UNITED NATIONS aircraft manufactured in the United States will not fail, as did those of the German Luftwaffe on the Russian front in the winter of 1941-42, because of the cold weather. Neither will the sand and heat of the desert, nor the sticky mud and humidity of the equatorial jungles put them out of action. Because every military plane, for whatever front, is sent, not from a factory, but from a *modification center,* where it has been specially equipped to meet the conditions under which it will operate.

As far as we know, the United States is the only nation in the war using the modification center plan. Dozens of them are either already in production or rapidly nearing completion in the United States and foreign countries. And it is their combined production, in the final analysis, that is the military aircraft production of the United States.

Undoubtedly much of the credit for the mechanical life and performance records made by U. S. aircraft is at-

In first stations, cowling and equipment is removed, engines "pickled", and turrets covered in preparation for modification.

Removed cowling, parts, and equipment are stored in racks attached on top of outer wings. Racks are made of plywood, with two partitions creating three compartments. Feet have angle brackets which match existing screws in surface of wing and are fastened down by them. Lower propeller blades are covered with canvas slipovers.

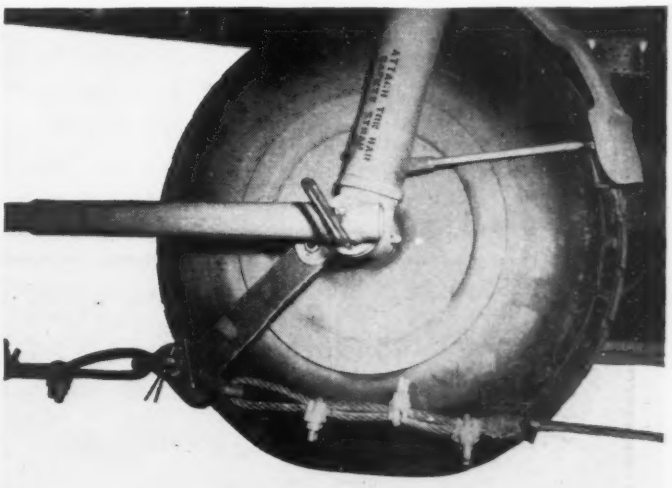
Due to nature of work, crowded working conditions prevail and will continue to be a controlling factor in procedures in modification centers. Here, a crew of four works around an engine nacelle.

tributable to the fact that each ship is weatherized and otherwise equipped for specific theaters of operation or special missions. What is done is, of course, a military secret. How it is done will be told, in part at least, in this article.

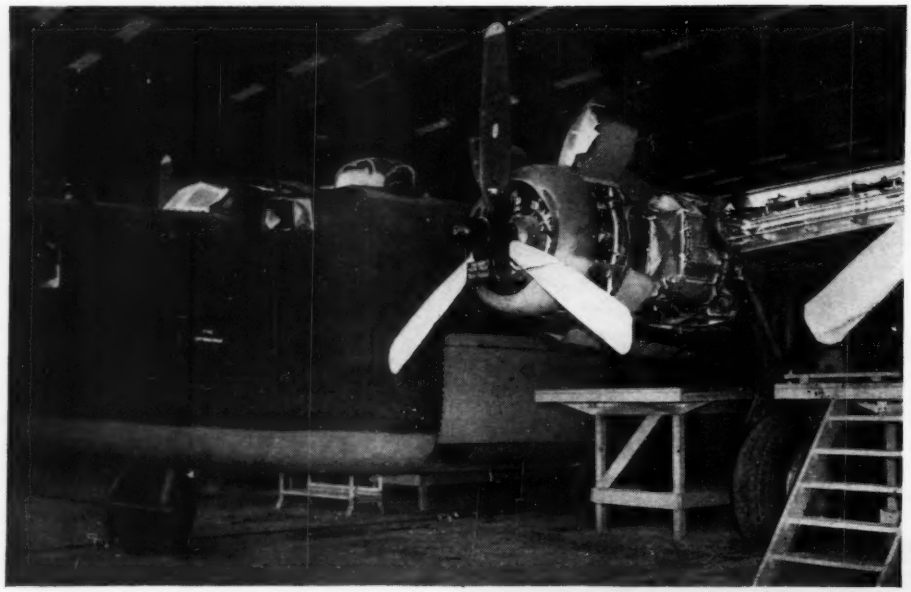
Chronologically, orders for modification are received from the several fronts by the Special Projects Branch, Production Division, of the Materiel Center, AAF, Wright Field. There they are studied and, if practicable, forwarded to the modification center handling the model or type of plane involved.

An order may include many changes, some of them of such nature they will always have to be made in the modification center, and others that will be made there only temporarily. We estimate that about 25 percent will always be what we now call "permanent" work,

Preparatory to moving line of planes, workmen lift removable leaf over wheel slot in work stand. Note drip trough beneath nacelle. Work stands are 33x14 ft. and are anchored to floor. They have lower shelf for storage of tools and parts. Leaf is 3½x10 ft.



Towing device is so designed that pull is direct from cable to cable, rather than through axles of nose wheels. When pressure is relaxed, arm attached to axle will drop to vertical position, allowing cable to rest on floor, out of way. Steering bar remains in place, but free end rests on floor between moves.



Line has moved about 12 ft. and port landing wheel is about to emerge from slot in work stand. When line halts and next ship is in position, its port and starboard wheels will be just behind work stand, but not in slot.

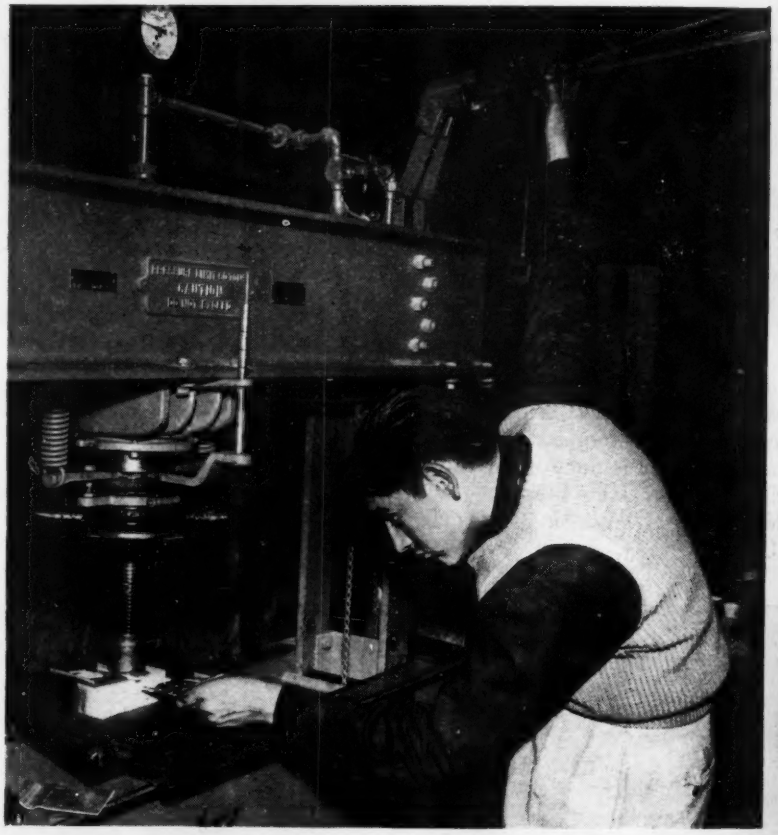
This 60-ton hydraulic press is forming a bracket with a hardwood female die. Operator checks his progress by comparing part in press to accepted one. Press was purchased from automotive supply concern and was used in garages for pressing gears on and off shafts.

such as weatherization installations, and 75 percent will be of a "temporary" nature, so handled only until the parent plant can put them into production.

For the latter the Modification Center engineering department makes drawings that will put the change into production and also sends copies to the parent plant. There, if necessary, they are redrawn and steps are taken to incorporate the changes on the production line. The center will continue to fabricate and install the changes until they come through permanently from the parent plant. By that time, however, orders for still other changes will very likely have arrived and will be in progress. It is expected that this routine will continue throughout the war. And, of course, installation of weatherization and special mission equipment will always have to be done in the modification center.

When the engineering department has finished its sketches, to be followed later by drawings, the tooling and methods departments go into action.

(*Turn to page* 329)



Salvage is a manufacturing problem common also to modification centers. Here, women pick certain sizes of rivets from a slow-moving conveyor belt. Mixed rivets are dumped into hopper at left, and those not picked out fall into a box at end of conveyor, to be returned to hopper and put through again and again until all sizes have been sorted. This operation is about the nearest approach to "mass production" reached in modification center.

The B.F. Goodrich Airplane of the month

CESSNA BOBCAT

WINGED UNIVERSITY. Many of the skilled pilots who will bomb the Axis tonight received their first Twin Engined instructions in Cessna Bobcat AT17 Bomber Pilot Trainers. This sturdy ship, used by both the United States Army Air Forces and the Royal Canadian Air Forces, has earned an enviable reputation for excellent flight characteristics combined with high serviceability. The many B. F. Goodrich products, including famed Silvertown Tires used by Cessna, have contributed to this fine record. This month B. F. Goodrich salutes the Cessna Bobcat, a great plane with a fine record on training fields throughout North America.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

Smooth Contour Tires for today's faster-landing military aircraft

TODAY'S WARPLANES are landing at greatly increased speeds. They're landing on military airfields . . . often short, often rough, often muddy . . . and they're coming in safely. That's because improvements in landing equipment have kept pace with increased need for safer ground control.

B. F. Goodrich has played an important part in improving warplane ground control by the development of Smooth Contour Silvertown Tires. In addition to giving the same excellent performance and endurance for which B. F. Goodrich Low Pressure Silvertowns are famous, these new tires meet two other basic needs of fast-landing warplanes:

MAXIMUM BRAKING: When warplanes come in fast on short, rough fields, they have to be able to stop quickly. And they *do* stop quickly when B. F. Goodrich Smooth Contour Silvertowns are used on wheels equipped with Expander Tube Brakes.

These brakes expand radially against the entire inner surface of the brake drums. The B. F. Goodrich Smooth Contour Silvertown was specially designed with a large bead diameter which permits the use of larger wheel rims and consequently larger brake drums. This, in turn, increases the braking surface and the grip of Expander Tube Brakes so that they can stop fast-landing warplanes quickly.

MAXIMUM GROUND CONTACT: Warplanes must be able to maneuver fast on the ground, too, without the danger of skidding. B. F. Goodrich Smooth Contour Silvertowns have *a wide footprint* and non-skid tread which meet the need for maximum ground contact and stability.

Right now, the B. F. Goodrich Smooth Contour Silvertown is proving its worth on world battlefronts. It is filling the need for safer ground control at high speeds. And it's just one more reason why leading aircraft manufacturers specify with confidence, "B. F. Goodrich Aviation Equipment."

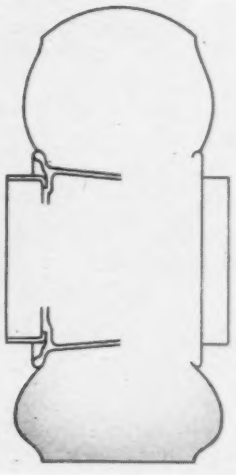
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

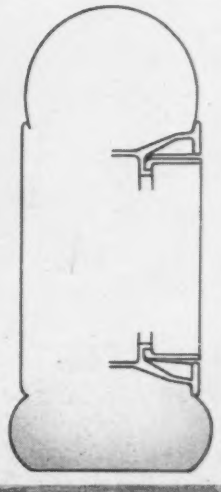
ARMY E NAVY

Why Smooth Contour Silvertowns mean

SAFER LANDINGS AT HIGH SPEED!

The advantages of Low Pressure and Smooth Contour Silvertowns are shown in these sketches. The Low Pressure Silvertown (a), with smaller bead diameter, has adequate braking surface for transport and slower-speed ships, *plus* extra cushioning vital in many operations. The Smooth Contour Silvertown (b), with much larger bead diameter, provides room for the extra braking surface needed to stop a fast warplane quickly. It offers the advantages of both high pressure and low pressure tires, modified to meet military requirements of speed.





Note the wide footprint and non-skid, self-cleaning tread—both features of B. F. Goodrich Smooth Contour Silvertowns which assure maximum ground contact and stability.

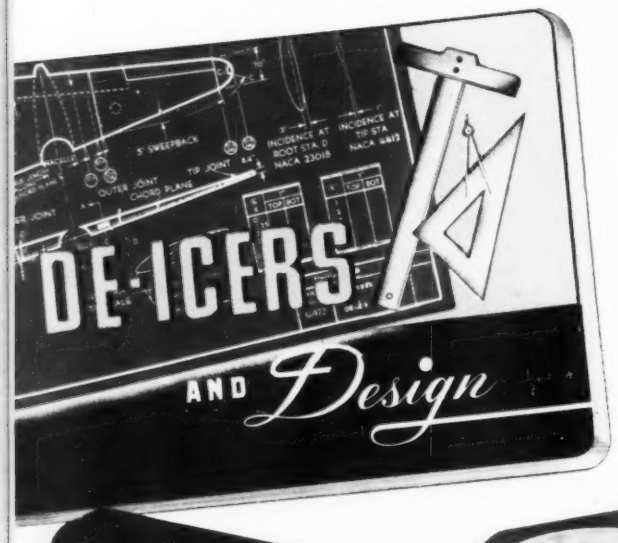
This test tells the tale. The heavy road wheel on this machine is rotated to simulate landing speeds up to 150 m.p.h. When the desired speed is reached, tire is thrust against road wheel and braking applied until it comes to a full stop. By timing this operation, the exact rolling distance can be found.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

De-Icer Slide Film for Designers—Now Available!



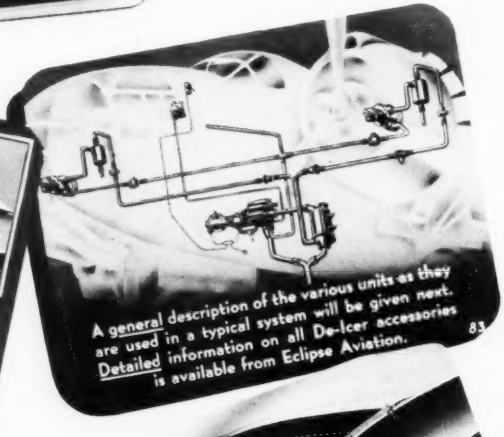
ALL DESIGNERS OR MANUFACTURERS OF AIRCRAFT SHOULD SEE THIS IMPORTANT STEP-BY-STEP STORY OF DESIGN FOR DE-ICER PROTECTION. This reading slide film sets forth the "know-how" of providing the best De-Icer protection for your new airplanes in a clear, detailed manner that technical men will appreciate. Some of the topics covered are design procedures, types, methods of installation, basic air supply system, attachments, and aerodynamics of the De-Icer.

A reproduction of the film is presented in an attractive, pocket-size booklet, and copies are available to designers and engineers on request.

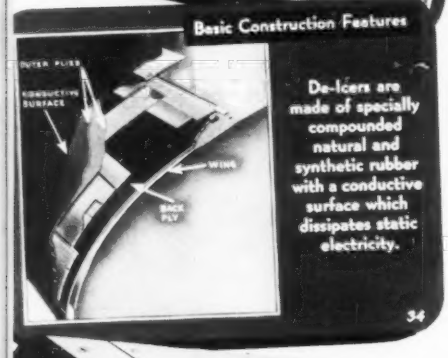
The pictures on this page will give you a hint at the data you may expect to find in the film. If you have any part in the planning of airplane design, be sure to send us your order, as explained in the ordering instructions below.

Other films in the series, announced earlier, are "The Development of the De-Icer," and "De-Icer Servicing and Installation."

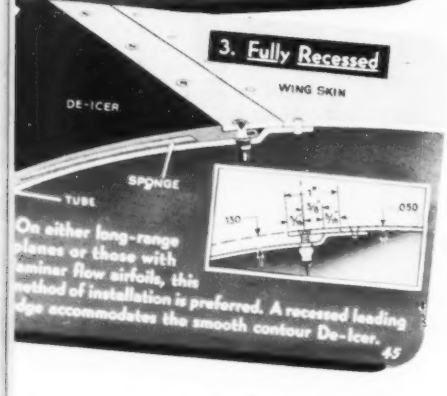
De-Icer Attachment
Let us examine the De-Icer attachment more closely. Here are the main elements —
Rivnuts — act as nut plates to hold the
Screws — that fasten the De-Icer bead and
Fairing Strips — that clamp the beads and fair the contour smoothly into the wing.
FAIRING STRIP
DE-ICER
BEAD
WING
RIVNUT
ATTENUEER

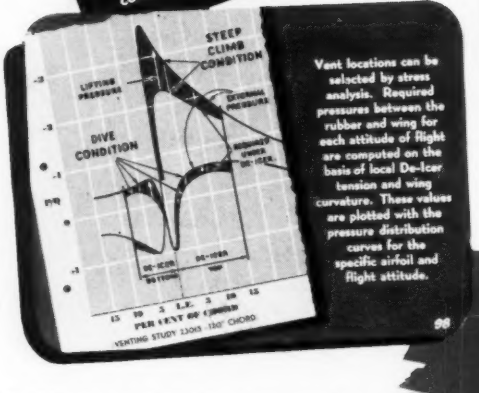

A general description of the various units as they are used in a typical system will be given next. Detailed information on all De-Icer accessories is available from Eclipse Aviation.
83

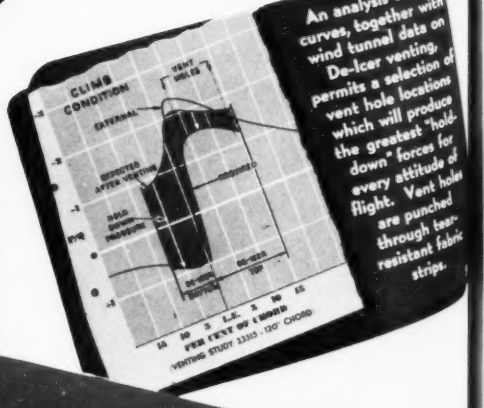
In protecting wings with fixed slots, the bottom of the wing to the slot should be protected
movable portions of the De-Icer. The De-Icer
can be notched to permit concealed installation
the attachment with
standard Fairing.
BEFORE INSTALLING
NOTCHES
BEAD


Basic Construction Features
OUTER PLY
CONDUCTIVE SURFACE
WING
BACK PLY
De-Icers are made of specially compounded natural and synthetic rubber with a conductive surface which dissipates static electricity.
34

De-Icers for large duct openings may have special beads to permit smooth attachment within the duct, using regular Fairing Strip. Rubberized patches seal corner notches to prevent the entry of air and water.
67

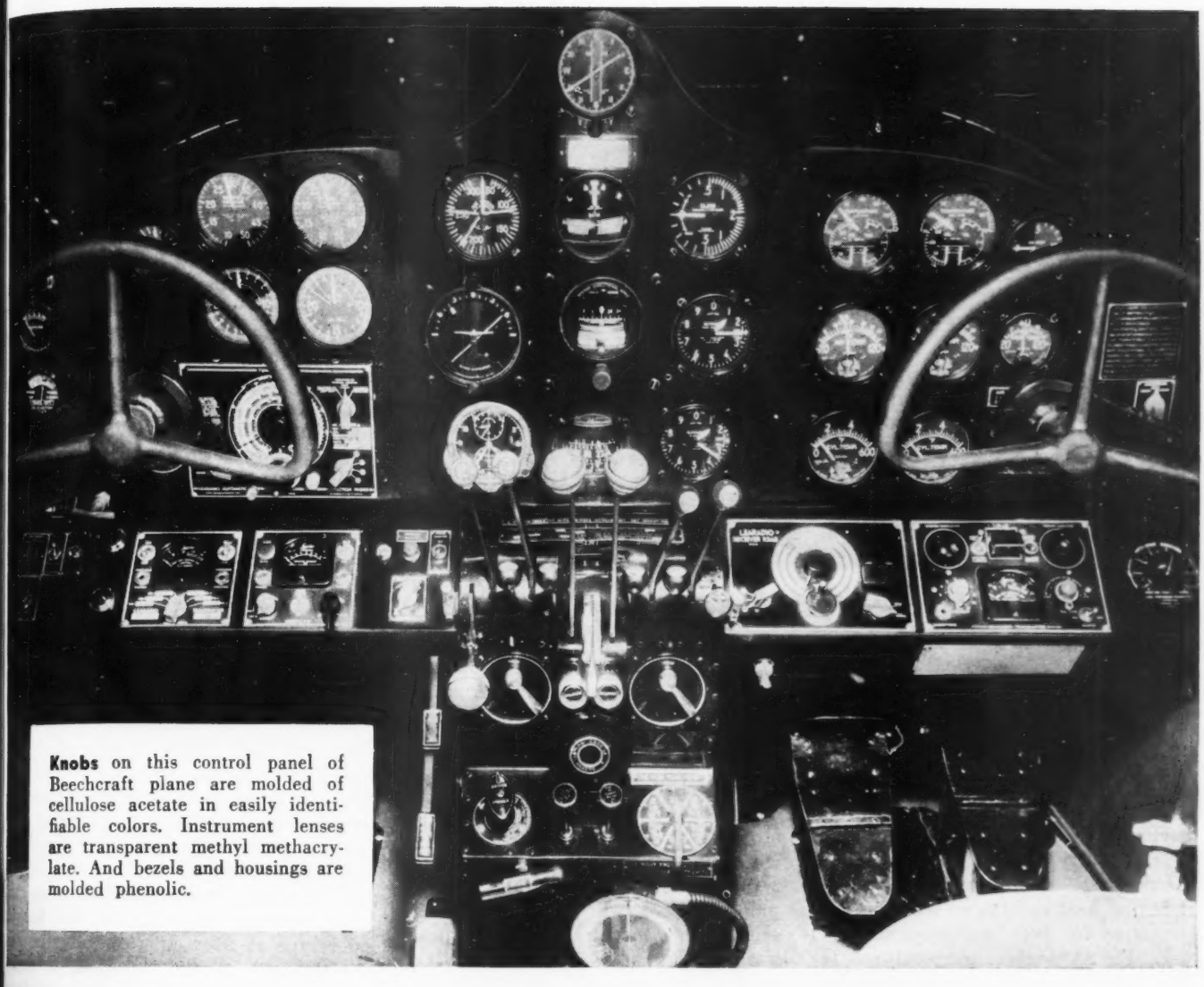

3. Fully Recessed
DE-ICER
WING SKIN
SPONGE
TUBE
On either long-range planes or those with laminar flow airfoils, this method of installation is preferred. A recessed leading edge accommodates the smooth contour De-Icer.
45


STEEP CLIMB CONDITION
DIVE CONDITION
LIFTING PRESSURE
DETACHING PRESSURE
Vent locations can be selected by stress analysis. Required pressures between the rubber and wing for each attitude of flight are computed on the basis of local De-Icer tension and wing curvature. These values are plotted with the pressure distribution curves for the specific airfoil and flight attitude.
98


CLIMB CONDITION
EXTERNAL
DEPICTED AFTER VENTING
HOLD DOWN PRESSURE
An analysis of the curves, together with wind tunnel data on De-Icer venting, permits a selection of vent hole locations which will produce the greatest "hold-down" forces for every attitude of flight. Vent holes are punched through tear-resistant fabric strips.

HOW TO ORDER—All the De-Icer slide films and booklets are available without cost when requested on your business letterhead. Address your inquiry to the B. F. Goodrich Co., Dept. 7191, Akron, Ohio. The booklets will be furnished in sufficient quantity for all members of your organization who might be interested. "De-Icers & Design" will be especially helpful to airplane manufacturers, designers and engineers, while "Development of the De-Icer" and "De-Icer Servicing and Installation" will be of interest to everyone concerned with De-Icer operation, maintenance and servicing.

B. F. Goodrich
Aeronautical Division
Akron, Ohio



Knobs on this control panel of Beechcraft plane are molded of cellulose acetate in easily identifiable colors. Instrument lenses are transparent methyl methacrylate. And bezels and housings are molded phenolic.

POINTS ON PLASTICS In Aircraft Engineering*

Part I

By JOHN SASSO, *Product Engineering*

In strikingly increasing number, plastics are "taking to the air." This timely three-part article—dealing in turn with fundamental factors, comparative properties, and principles of molding and design—provides pertinent data on the engineering and production of plastic components for aircraft.

IN PREPARING to design an aircraft component consisting wholly or in part of plastic material, the engineer must investigate four factors:

1. Physical, thermal, electrical and chemical properties.

2. Design limitations of the plastic material, which relate somewhat to its physical properties but which to a great extent will depend on the method of production of the finished part.

3. Economy of production, which takes into consideration the cost of molds and tools, tooling, and expected quantity of parts to be obtained from the initial tooling.

4. The cost of the plastic product in relation to other materials, considering advantages the plastic part may have in structural qualities, lightness of weight, and appearance.

The wide range of available plastic materials, many of which have special physical properties to meet certain application requirements, makes the choice of a proper material difficult. One method of classifying plastics is to divide the materials into thermosetting and thermoplastic groups. For purposes of definition, it may be said that a thermosetting material is one that under the application of heat and pressure polymerizes into a hard infusible product which will not soften to any extent

* Based in part upon key chapters in the author's new text *Plastics in Industry* published by the McGraw-Hill Book Co.

This landing-light cover on Curtiss P-40 is of formed Lucite, shaped to desired contour with heat via wooden dies.

on reheating and cannot be remelted and remolded. A thermoplastic material can be softened by heat and reharden-ed into solid state by cooling.

Because a material is thermosetting, it does not necessarily follow that it is particularly resistant to heat. Nor does it necessarily follow that because a thermoplastic can be softened by heat, it has no heat resistance. Working temperatures for both may approach 200 deg. F. At higher temperatures the thermosetting material may char, then decompose. The thermoplastic material will soften until fluid, then perhaps decompose if the temperature rises high enough.

Most plastics are inorganic in nature. They are derived from synthetic resins, cellulose derivatives, natural resins, and protein substances. So many types are available commercially that it is difficult to classify them simply. The accompanying list (Table I) covers only those plastic materials derived from synthetic resins and cellulose compounds. Groups not considered are the proteins (casein) and the natural resins (shellac, resin, asphalt, and pitch).

Basic materials for synthetic resins may be said to be coal, air, cellulose, limestone, petroleum, salt, and water. From these basic raws are obtained, urea, nitric acid, phenol, acetylene, phthallic anhydride, ethylene, methanol, formaldehyde, cellulose acetate, cellulose nitrate, ethyl cellulose, and many others.

The synthetic resins can be used with or without fillers, but they are usually compounded with fillers. The resins are available in liquid form for impregnating paper or fabric, for varnishes, adhesives, surface coatings, and the like.

Phenol resins are obtained from coal tar, which is distilled to produce anthracene oils. Phenol is separated from the oils by treatment with caustic soda. Formaldehyde is obtained from the oxidation of methanol or from wood alcohol.

Cellulose binders are obtainable from two sources: Cotton linters or wood pulp. Treated with nitric and acetic acids, then mechanically and chemically washed, these raw materials are synthesized into cellulose acetate resin. The cellulose resins are mixed with a plasticizer which is added in some cases to increase flow properties for ease of molding, added to others to increase impact strength. These plasticizers include sulfonamides, phthalyl glycolates, and triphenyl phosphates. They have a marked effect on physical properties. Generally, tensile and compressive properties decrease an increasing plasticizer content. As a result, the grades of plastic compounded for ease of flow will show minimum strength properties, and vice versa.

Fillers

Added to resins, fillers make a wide range of properties possible. Various fillers may be compounded with the resin to obtain special high electrical, chemical, and impact resistance, or to improve moldability. Typical fillers for phenolics include wood flour, cotton fabric, graphite, asbestos, mica. Urea resins are generally compounded with purified wood cellulose (alpha-cellulose). Effect of fillers on properties may be easily seen by reference to our accompanying Table II.

Wood flour is the most common filler used in phenolic materials. This filler has a low specific gravity, therefore the number of moldings per pound is higher. Other advantages obtained with its use are good moldability, good appearance of the molded surface, and low heat conductivity. However, wood filled phenolics have only fair impact strength and are subject to shrinkage in service. Applications of the general purpose wood-filled phenolics are limited by strength and heat resistance color.

Cotton fillers improve impact strength and increase impact resistance. Though rag filler is generally required for higher impact strength, cotton flock is widely used for parts requiring medium impact strength. Parts made of cotton filled phenolic can be easily buffed and polished, and can be tableted easily—an important factor in maintaining high hourly production rates in compression molding operations.

Rag fillers increase impact strength, this increase depending on the length and type of fiber. Increase in strength is obtained at the expense of some other properties, notably poor surface finish and poor machinability. Intricate parts cannot be molded easily of rag-filled phenolic because of the relatively poor flow of this material in the molding operation.

When heat resistance is paramount in the molded part, asbestos fillers are compounded with the resin. Asbestos fillers also impart a good degree of water resistance, as well as resistance to most acids. These fillers somewhat retard the molding operation because of reduced flow. Another disadvantage is the high specific gravity, which of course proportionately reduces the output of parts per pound of molding material. (See data on specific gravities in Table III.)

Mica is used to impact good electrical resistance. It is the filler for low-loss compounds with excellent insulating qualities. Poor machinability is a characteristic. Because of brittleness, parts molded of mica-filled compounds cannot be drilled.

Graphite fillers, generally used in combination with wood flour, asbestos, and rag, impart acid resistance and improve molding qualities because the graphite serves as lubricant. However,

TABLE I. SYNTHETIC RESINS

Thermoplastic	Thermosetting
Polystyrene	Phenol- or Cresol-aldehydes
Polymethyl methacrylate	Urea-aldehydes
Polyvinyl chloride-acetate	Urea-melamine-formaldehyde
Polyvinyl chlorides	Aniline-formaldehyde
Polyvinyl acetate	Glyceryl-phthalates
Polyvinyl acetals	
Vinylidene chloride	

CELLULOSE DERIVATIVES

Cellulose nitrate	Cellulose acetate-butyrate
Cellulose acetate	
Ethyl cellulose	

TABLE II. PHYSICAL PROPERTIES OF PLASTICS

	Tensile Strength lb./sq. in.	Compressive Strength lb./sq. in.	Flexural Strength lb./sq. in.	Impact Strength Izod, ft. lb./in. Notch ½x½" in bar
Phenolic				
(wood flour)	4,000–12,000	16,000–36,000	8,000–15,000	0.20–0.40
(mineral)	4,000– 8,000	18,000–36,000	8,000–15,000	0.22–0.72
(macerated fabric)	5,000– 8,000	20,000–32,000	8,000–13,000	0.8 –4.8
Cast phenolic	8,000–12,000	20,000–25,000	9,000–12,000	0.5 –0.6
Laminated phenolic				
(paper)	7,000–18,000	20,000–40,000	13,000–20,000	0.6 –7.6
(cotton)	8,000–12,000	30,000–44,000	13,000–30,000	1.4 –15
(asbestos)	7,000–12,000	18,000–45,000	10,000–35,000	1.8 –11
Phenol furfural				
(wood flour)	6,000–11,000	28,000–36,000	8,000–15,000	0.30–0.56
(mineral)	5,000–10,000	24,000–36,000	8,000–20,000	0.32–0.74
(fabric)	6,000– 8,000	26,000–30,000	10,000–13,000	1.20–4.60
Urea	5,000– 7,000	24,000–35,000	10,000–13,000	0.28–0.32
Vinyl chloride	8,000–10,000	10,000–12,000	12,000–14,000	0.4 1.2
Vinylidene chloride	5,000– 7,000	7,500– 8,500	15,000–17,000	2–8
Methyl methacrylate	4,000– 7,000	10,000–15,000	10,000–15,000	0.2 –0.4
Polystyrene	5,000– 9,000	11,500–14,500	8,000–19,000	0.3 –0.50
Ethyl cellulose	3,000– 9,000	10,000–12,000	4,000–12,000	0.6 –6.5
Cellulose acetate butyrate	2,500– 7,500	7,500–22,000	2,000–13,000	0.8 –5.5
Cellulose acetate	3,000–10,000	5,000–27,000	2,000–18,000	0.7– 4.0

TABLE III. SPECIFIC GRAVITIES OF MATERIALS

Material	Specific gravity	Material	Specific gravity
Aluminum	2.67	Mica	2.85
Amber	1.1	Oak	0.86
Asbestos	3.0	Phenolic:	
Brass (70-30)	8.4	cast	1.27–1.32
Bronze	8.8	wood flour	1.25–1.52
Casein	1.33	laminated	1.34–1.55
Cellulose acetate	1.27–1.63	mineral	1.50–2.09
Cellulose acetobutyrate	1.20–1.22	fabric	1.37–1.40
Cellulose nitrate	1.35–1.60	Polystyrene	1.06
Copper	8.9	Porcelain	2.3
Ebony	1.23	Rubber, hard	1.12–1.80
Ethyl cellulose	1.14	Silver	10.5
Glass, plate	2.6	Steel:	
Iron, cast	7.22	stainless	7.78
Lead	11.38	cast	7.81
Magnesium (commercial)	1.76–1.83	Urea	1.45–1.50
Maple	0.68	Vinyl resins	1.25–1.41
Methyl methacrylate	1.18		

poor heat conductivity is noted. This filler is in phenolics for moldings of bearings, caster wheels, slides, and the like.

Phenolic Resins

Phenolic resins are thermosetting in nature and in their final or cured forms are infusible and insoluble. They can be compounded with fillers and reinforcing agents so as to obtain a broad range of physical, electrical, chemical, and molding properties. This material is very widely used in industry. Cast phenolics have recently been found useful in industrial applications such as pump gears. They have long been used because of their gem-like luster, wide color selection, and easy machinability.

On the other hand, the molded phenolics have only fair machinability and are definitely limited in available colors. Molding materials are available in powdered, granular, or blank sheet form. Laminated and cast materials are available as sheets, rods, bars, and tubes. Molded phenolics are used for cams, bearings, switch boxes, motor housings, and radio housings. Laminated phenolics are fabricated into gears, bearings, and parts requiring electrical insulating characteristics.

Urea-Formaldehyde

The urea plastic materials possess the unusual combination of thermosetting qualities with a wide assortment of colors, including many of the delicate pastel shades. Ureas have good dielectric qualities, good tensile and flexural strength. Urea molding materials are available in powder or granular form and the laminated materials are available in sheet form. Urea moldings have been successful for such applications as instrument housings. Urea adhesives have been an important factor in the recent expansion of the plywood industry.

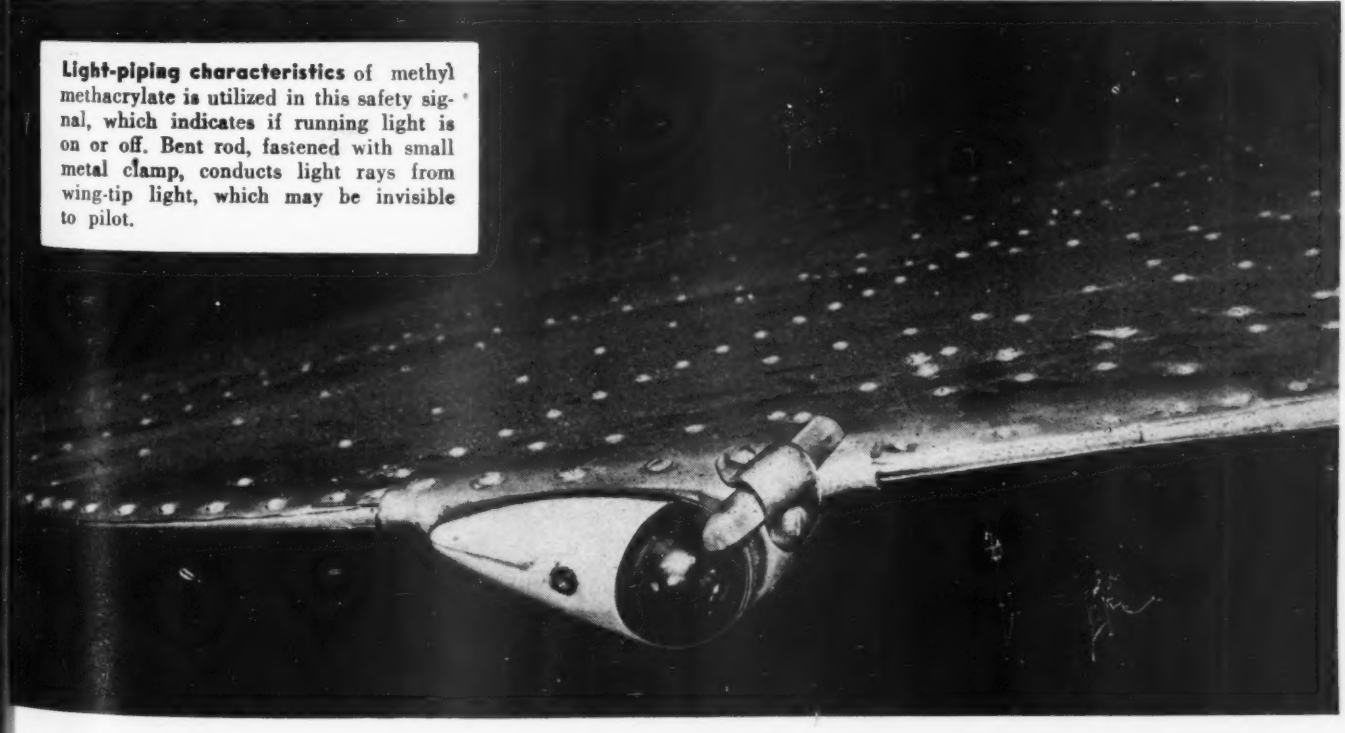
Acrylic Resins

The acrylic resins possess some of the most desirable optical properties of the transparent plastic materials. Because of crystal clarity, stability, resistance to weathering and moldability, acrylics have attained wide popularity as an organic glass. Since acrylics are thermoplastic in nature, they can be easily fabricated into complicated shapes or forms wherein transparency and "light-piping" are useful characteristics. Acrylic resins are available as molding powders or as cast sheets, rods, bars, and tubes. Typical applications include aircraft cockpit enclosures and "blisters," instrument dials and bezels, transparent housings, molded reflectors, and the like.

Polystyrene

This thermoplastic material is noted for its excellent dielectric properties and optical clarity. The material ex-

(*Turn to page* 403)

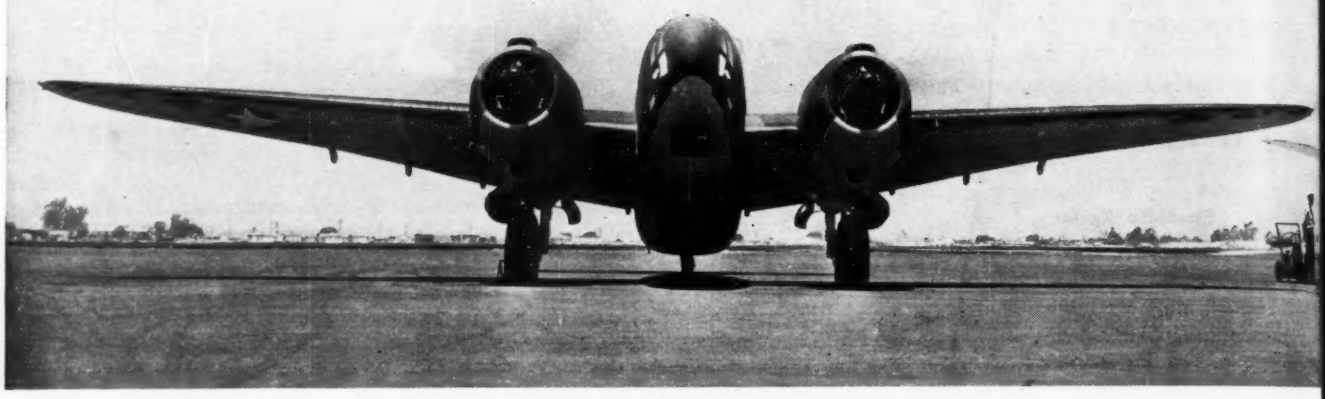


Light-piping characteristics of methyl methacrylate is utilized in this safety signal, which indicates if running light is on or off. Bent rod, fastened with small metal clamp, conducts light rays from wing-tip light, which may be invisible to pilot.

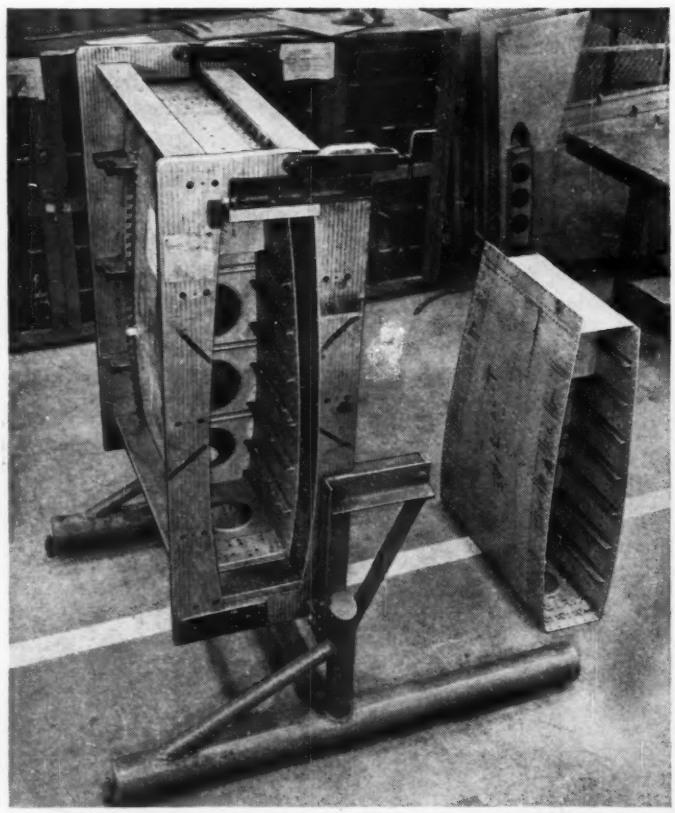
Aircraft Tool Planning

Part I

By **RICHARD H. LUDERS,** *Manufacturing Planner, Vega Aircraft Corporation*



Large scale production is largely a matter of good tooling which, in turn, depends on sensible tool planning. Proper job analysis is likewise essential to good tool planning. This article offers 20 essential points.



Empennage center section coordinated drill jig used at Vega. Section is drilled as a complete unit and coordinated (full size holes) to attaching stabilizer and fuselage.

Vega outer wing leading edge steel assembly jig. Noteworthy are main beam location by pinned fittings and lightening hole pick-up, contour plates at leading edge, doubler and corrugation locators, hinged leading edge rib locator support, and stringstops on end plate.

Today, with the United States at war, and aircraft in demand, large scale production has come to the airplane industry. In its wake has arisen the great need for tool planners, or manufacturing planners as they are sometimes called. These men, armed with the engineering prints and pertinent information pertaining to the ship, visualize and direct the building of the special and standard tooling necessary for manufacturing the airplane. They also formulate the fabrication and assembly methods for the making of thousands of details, subassemblies, major assemblies, and the final assembly of the ship. This entire program of tooling and assembly procedures must be prepared prior to, and coordinated with, production.

The tool planner, as an individual, must be experienced and technically equipped to meet such an important responsibility. His duties not only involve the writing of special tool orders to the tooling shops, but also the writing of shop orders (operation sheets) instructing the workers on the fabrication and assembly lines in methods and procedures necessary for the manufacture of the parts or assemblies. As the tool and shop orders are released, many problems come up pertaining to these tools and the methods of fabricating or assembling. With such a scope of duties, the tool planner continuously confers with the departments of engineering, lofting, stress, dispatching and scheduling, tool design, tooling shops, fabrication and assembly lines, outside production, purchasing, Army and Navy inspection, salvage, tool and parts inspection, etc.

Tool planning thus serves as the heart of the aircraft industry, by translating the engineering blueprints into tooling and methods of manufacture needed to create physically the airplane.

When a tool planner plans a job, whether a detail or assembly, he takes many factors and problems into consideration. He should consider the following 20 points. And after taking each into account, he should plan the work according to the factors that affect the particular job at hand. Proper job analysis is essential to good tool planning.

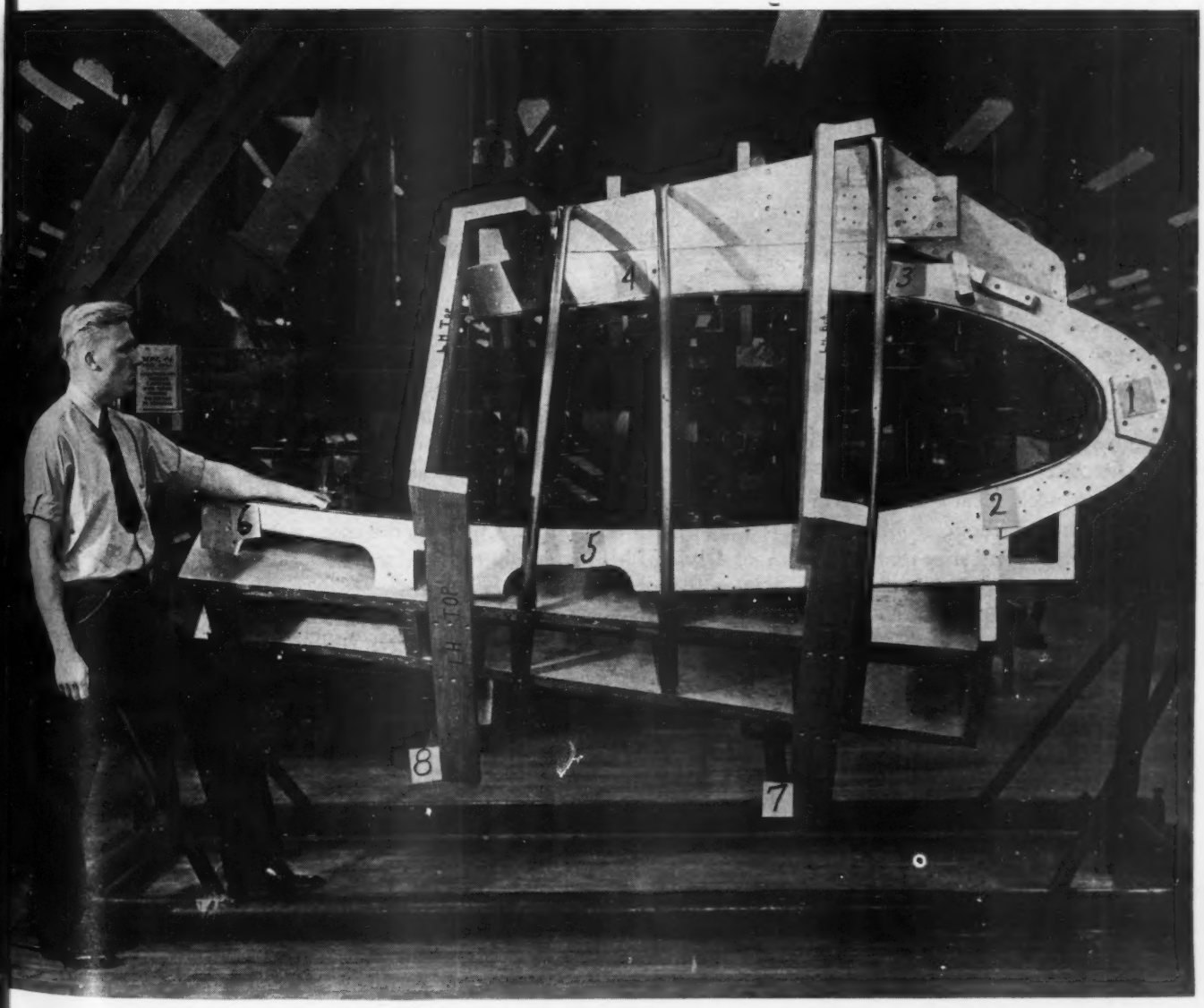
1. Ultimate Part Cost

The ultimate part cost, or unit cost, is the most important controlling factor in the planning of any detail or assembly. If few parts are to be made, low cost tooling is necessary to hold down the cost of the part. If a considerable number of parts are made, more expensive tooling is justified. In planning, the cost of tooling, then, is justified only as to the number of parts made. There are a few cases where it takes expensive tooling to make the parts regardless of quantity. These cases are becoming few and far between, as engineers are today designing for production and not for just one or two models.

2. System of Coordination

Any one, or a combination of the four systems of coordination (1. pilot size hole coordination, 2. full size hole coordination, 3. assembly jigs, or 4. as-

Wing center section master gage and check fixture employed at Vega.



Enlist GIRLS for MANpower in Your Screw Driving Army

WOMEN DRIVE PHILLIPS SCREWS EASILY!

Now you can recruit women for your screw driving army and be sure of fast, *skilled* work from the very start.

Big muscles aren't needed to drive Phillips Recessed Head Screws. Further, it requires no mechanical aptitude . . . even novices produce without wobbly starts, slant-driven screws and slips that cause accidents or mar work.

Automatic centering of the driver in the Phillips Recess makes such efficient use of turning power that screws set-up uniformly tight . . . with so little effort that workers maintain speed without tiring. Screw and driver "become one unit," making driving so easy and fool-proof that work is greatly speeded up, regardless of the driving method employed. In most cases, power driving becomes practical.

They cost less to use! Compare the cost of driving Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs less to have the many advantages of the Phillips Recess!

KEY TO FASTENING SPEED AND ECONOMY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

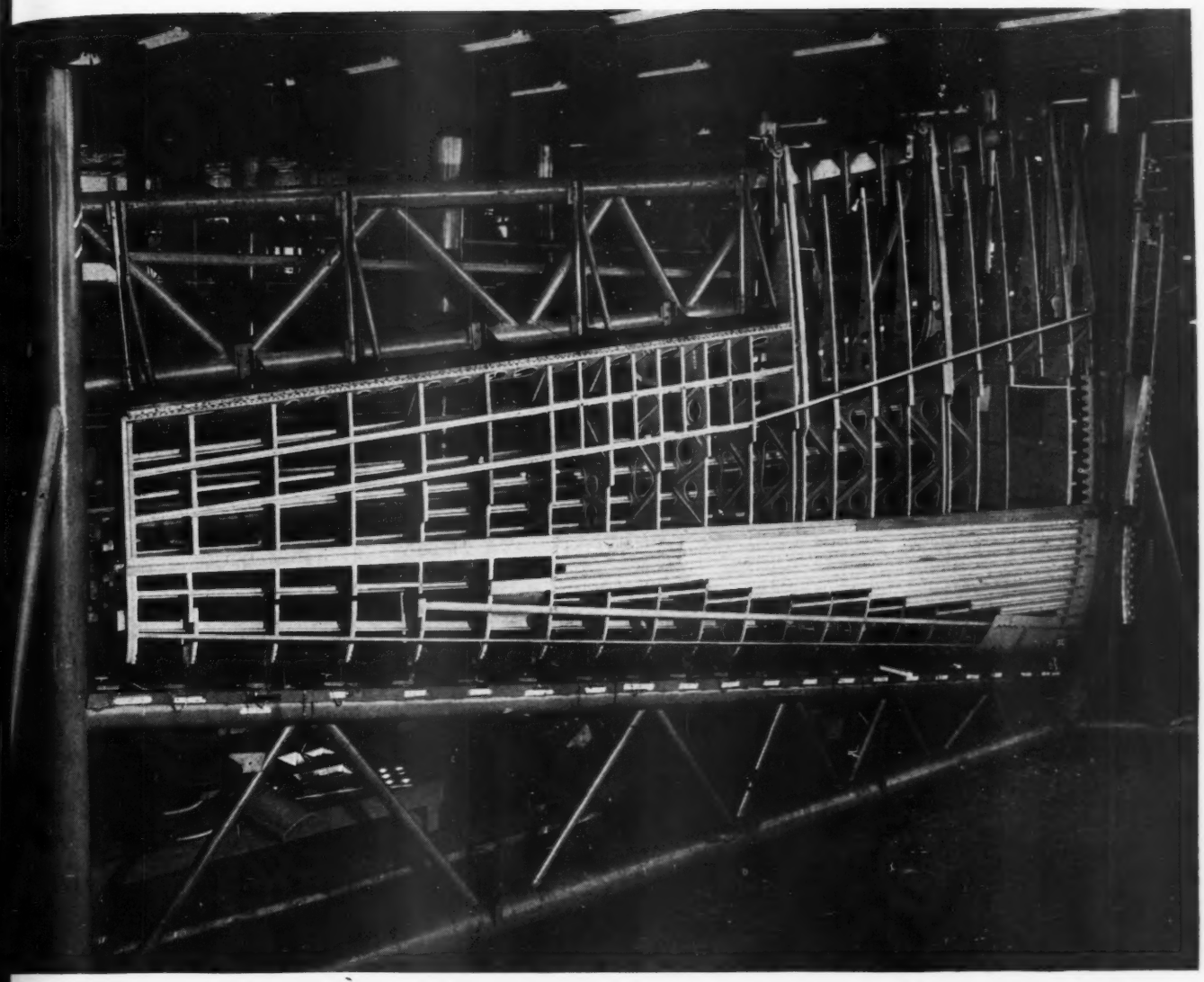
Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLT

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Reading Screw Co., Norristown, Pa.
Pheoll Manufacturing Co., Chicago, Ill.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.



Major steel assembly jig for outer wing panel. Note pick-up of aileron hinge line, main beam at inboard and outboard end, leading edge of nose ribs, track and trailing edge ribs, and corrigation locators.

sembly drill jig) should be considered as per the *importance* of the detail or assembly, and also the *number of parts* or assemblies to be handled. For a small subassembly, one which is only a minor support or attachment and is to be attached to a larger and more important structure, the details may be assembled by means of pilot size hole coordination. If a subassembly location is vital, and its details must be closely held with respect to each other, then full size hole coordination may be used. A less expensive means, if location of parts is important, would be the use of the assembly jig. If this same unit should require close location, and a hole layout within its assembly which must coordinate for interchangeability to another, then the assembly drill jig should be used. Further consideration will depend on experience, common sense, and complete analysis of the job.

3. Attaching Points (Interchangeability)

In considering a set up for an assembly, the plane's coordinating points and attaching fittings should greatly concern the planner. These are important points of interchangeability. Whether the attachment of structures is made by means of two flush surfaces bolted together, or two or more fittings pinned together, the problem *demands extremely close tolerances* and very careful, intelligent planning. Contours at such points must be held very closely; the relation of these attaching points to their own assembly structure, as well as to the adjacent coordinating structures must be held; and finally the detail that carries these points of attachment must be fabricated under close tolerances. Care should be taken to plan master tools to perpetuate and check these attaching points.

4. Master Tooling

To build successful coordinated tooling and interchangeable parts or assemblies a starting, or reference, point is needed. Just as photographic prints are made from a negative, so are various coordinated tools made from a master tool. A master template carries the layout as designated per engineering and loft, showing such reference lines as water lines, station lines, butt lines, and also the contour (inside or outside mold line) at that particular section of the ship. The drill jig template is a template either made from one of a series of coordinated jigs, or else made prior to the maknig of any jigs.

If the former is true, the template is nested and drilled in the jig in a manner similar to that of a part. This template then carries a hole layout around which other coordinating jigs can be built picking up all or part of the same hole layout. If the latter should be true, the template may be made and shaped to the main coordinating part (part to which everything is coordinated) and the hole layout established on it. All jigs are then built and coordinated to this established source. Transfer plates are used much the same way in transferring hole layouts but are more accurate because the holes are bushed in $\frac{3}{8}$-in. to $\frac{1}{2}$-in. steel plates.

The Master Gage is a negative structure which carries hole layouts for co-

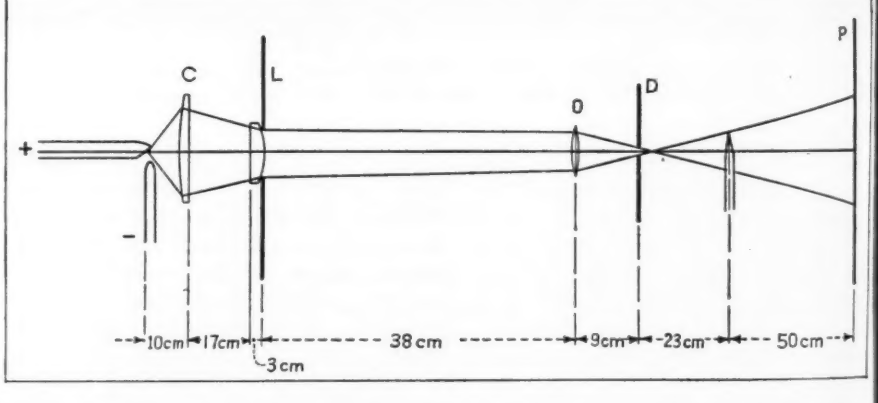
(*Turn to page* 374)

Airflow Visualization Opens New Avenues of Research

By ERWIN J. SAXL
Saxl Instrument Company, Inc.

With improvement in method of observing air streams, plus development of photographic means for recording airflow phenomena, new progress is foreseen in field of aerodynamics

Figs. 1 and 2. Photo of improved projector equipment (above) and schematic diagram of its arrangement (below).



IT IS NOW POSSIBLE to make visible in the laboratory the phenomena encountered under conditions of high air velocity—the visualization either of gases passing at high velocity past objects or of objects passing at great speed through gases.

In short, through the development of the projector equipment and the photographic approach herein described, improvements have been made in the optics which permit airflow observations and in the recording methods. In addition, the magnitude of the relative velocities at which the phenomena are observed may be calculated.

That there will be decided values to the aeronautical field in this new method and in the new phenomena discovered is readily evident. Progress is promised relative to the design of aerodynamic structures, also in connection with air stream action in internal combustion engines and problems of compressibility.

Suggestions are made for the further application of this new technique, and working hypotheses are offered for the explanation of the optical as well as aerodynamic phenomena observed.

Historical Review

In 1879, Ernst Mach[1] presented a paper before the Vienna Academy of Science on the Optical Investigation of Spark Waves, a technique developed by him which was essentially an arrangement for Schlieren observations. He pointed out means for making visible the flight of projectiles with the aid of spark discharges. This work on projectiles was subsequently carried further by von Cranz and Glatzel.[2]

A record of steam leaving air jets at high velocity was thereafter made by Ludwig Prandtl.[3] In further experiments the oscillation of Hartmann pulsators[4] was made visible by R. W. Wood.[5]

In the Prandtl arrangement, the nature of these experiments is based upon the direct observation of steam. It is not applicable to gases as such and, therefore, concerns itself with a limited field. In any event the writer is indebted to Prof. R. W. Wood for his description of his own method, cited in the following:

Prof. Wood's arrangement provided a right angle arc well housed to shut out outside light, with an opaque screen perforated by a very small hole and arranged so that the aperture can be

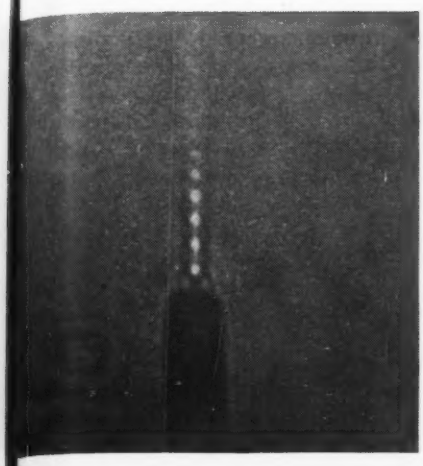
1. Ernst Mach and Gruse, *Optische Untersuchungen Der Funkenwelle-Sitzungs-Berichte*, Der Academie Der Wissenschaften, Vienna, V. 78, p. 467-481, 1879.

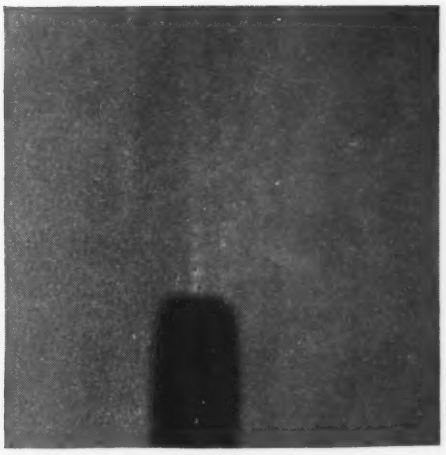
2. Cranz and Glatzel, Verh. D. Ph. Ges. 525, 1912.

3. Ludwig Prandtl, Göttingen, *Neue Untersuchungen Uber Die Strömende Bewegung Der Gase Und Dämpfe.* Physikalische Zeitschrift, V. 8, p. 23, 1907.

4. J. Hartmann, *Production by Means of an Air Jet of Acoustic Waves of Velocity Exceeding That of Sound*, Philosophical Mag., 8, 7, VII, p. 926-948, 1931.

5. R. W. Wood, *Supersonics*, The Charles R. Colver Lectures, 1937, published by Brown University, 1939.





Figs. 3 and 4. Air of 50-lb pressure is seen (left) escaping from jet. Right: Same jet with air leaving nozzle at 28-lb. pressure. Note that pictures are so sharp that even grain of projection screen appears.

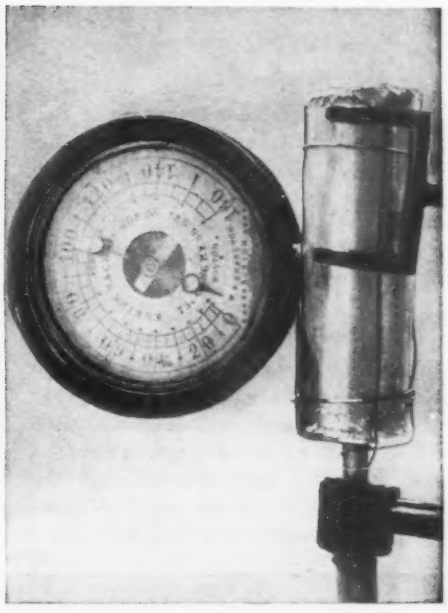


Fig. 5. Pressure chamber and air gage.

brought up close to the crater of the arc. The smaller the hole the sharper will be the image of the air jet and waves, but less light is obtained so that a happy medium must be found. The diameter of the hole is between ½ and 1 mm. In Prof. Wood's set up, the projection screen should be about 15 ft. away and the air jet held at a distance of about 1 m. from the pin hole. The best distance is found by experimenting. The apparatus has to be arranged in such a manner that practically no light reaches the screen except that which comes through the small hole. This is necessary in consideration of the comparatively low light intensity and limited field of vision that the pin hole projection of the positive crater entails.

The present arrangement is shown in Fig. 1. Instead of using a pinhole projector near the positive crater and thus limiting the useful cone of light, a collector lens is placed as near to the positive crater as the heat developed by the latter will permit. The total light intensity collected from over this larger illuminated area is several times as big as the projection through the pinhole. Moreover, due to the light being collected from over a larger sector, light sources other than the carbon arc can be applied.

The light (see Fig. 2) from the carbon arc *C* is reasonably parallelized by the collecting optical system. Extraneous light is excluded by the light shield *L*. This parallel beam of light is, thereafter, concentrated optically upon a focal point with the aid of the objective lens *O*.

An iris diaphragm *D* is placed at the focal point. In this manner an optical point source is produced instead of the pinhole used heretofore. This arrangement not only increases the light intensity and thus the brightness of the observation many times but in addition enlarges the total field of projection. An object may be brought at any point between the diaphragm *D* and the projection screen *P* and observed upon the latter. Fig. 2 shows the arrangement of the projecting optics schematically and gives the distances between the various units as used under actual operating conditions.

Photographs of the Phenomena

A camera was placed at an angle to the projection screen so that pictures projected thereon could be recorded with the camera. In order to increase the luminosity of the screen, a covering of glass beads was used.* Moreover, fast film was employed.

Figs. 3 and 4 are photographs of an air jet expelling a stream of compressed air. One shows the picture of air which reached a pressure of 50 lb. (before the orifice), the other is a photograph of the phenomenon that occurred at 28 lb. pressure. The method of determining the pressure is described subsequently.

The stream of air coming from a nozzle of only .0292-in. dia. broadens significantly. The air jet at 50 lb. gage pressure shows no uniform flow but a heavier serration. The individual subdivisions are further separated from each other and are broader than the divisions shown at the 28 lb. gage pressure. It may be noted that the pictures are so sharp that even the grain of the projection screen appears upon them. The phenomena were visibly observed over and above 20 lb. pressure. No pictures of this air stream were visible below that gage reading despite the fact that, as calculated subsequently, the phenomenon occurs over and above

*In a further development of the method described the photographic film or light sensitive paper may be placed directly upon the screen somewhat comparable to the way in which enlarging paper or negatives are exposed under an enlarging camera in special frames made for that purpose.

Figs. 6 and 7. On left, air is seen escaping from flat-pressed tube at high velocity. Right: Air of lower pressure escaping from broad nozzle and impinging upon inclined glass plate (projection through the plate).

a critical pressure of 13.1 lb. gage reading.

Polarized Light

It was investigated whether polarized light would have an effect upon the observation of the phenomena. No such change was noted by varying the angle between the polarized unit in front of the objective and the analyzing unit in back of the jet.

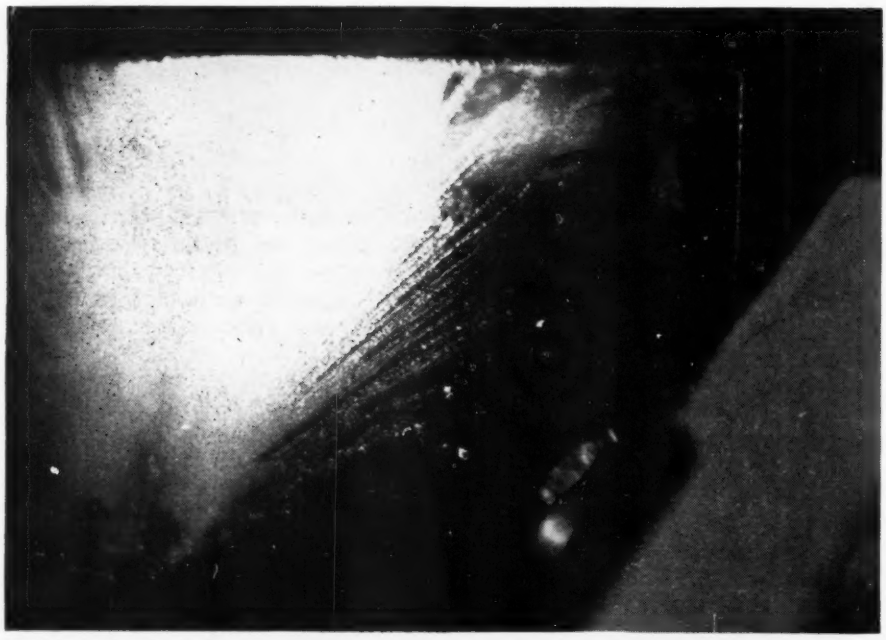
Determination of Pressure

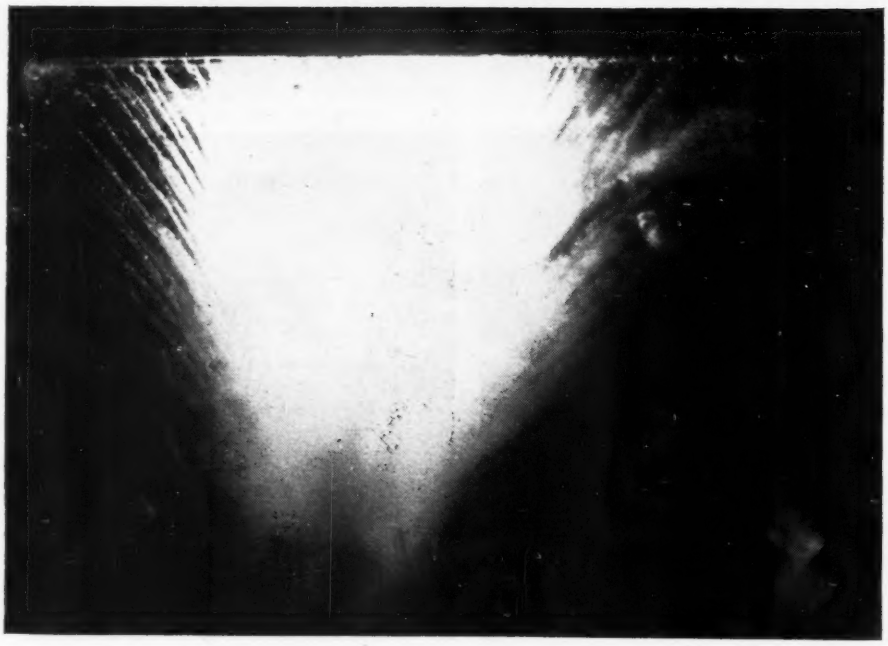
In order to determine the magnitude of the velocity of the air stream through the orifice, a pressure chamber was built with an attached gage. The following Fig. 5 is a photograph of the arrangement as in actual use. Air coming from a pressure generator with the maximum limit of 115 lb. pressure was sent through a short straight pipe and valve into the reservoir shown in Fig. 5. This reservoir consisted of a brass pipe 5½ in. long. The connecting pipe to the supply valve was inserted coaxially with this pipe. In order to keep turbulences at a minimum, this connection was made as short and straight as possible.

Fig. 8. High velocity air stream hitting inclined glass plate (projected from side).

In the opposite end of the air reservoir, a concentric hole was made with a No. 69 drill. This drill is the only one that just fitted into the hole of the air jet. It is reasonable, therefore, to state that the air jets photographed had a free opening of close to .0292 in. dia.

By visually comparing the stream of air leaving the orifice on top of the chamber and the stream of air leaving the air jet, similar pictures are obtained under both instances, provided the pressure is the same in every case.





Figs. 9 and 10. Above is seen flow pattern of a narrow stream of air hitting a glass plate, while below narrow air jet hits glass plate under a 45-deg. angle (photographed through plate).

Calculation of Speed of Air in Orifice

The following formula was used for showing the relation between the pressure before the orifice and the velocity of the air stream within the throat.[6]

$$V = \sqrt{2g \frac{K}{K+1} P_1 S_1} \qquad (1)$$

V ..... Velocity at throat or orifice
g ..... Gravitational constant (32.2 ft./sec.^{2})
K ..... Adiabatic coefficient (1.41 for normal air)
P_1 ..... Lb./sq. ft. absolute
S_1 ..... Specific volume (volume per lb./cu. ft.)

$$P_1 = [P_{(\text{gage})\ 14.7\ (\text{lb atmosphere})}] \times 144\ (\text{convertion factor to feet}) \qquad (2)$$

$$S_1 = \frac{\text{Gas constant } (53.34) \times \text{temp. abs. } (520 \text{ deg. F.})}{\text{lb./sq. ft. } (42.7) \times \text{ft. convertion } (144)} \qquad (3)$$

The observation was made at the pressures of 28 and 50 lb. gage reading. Compare with the following velocities in the throat as calculated by the above formula:

A.) At 28 lb. gage reading.. V = 1,023 ft./sec.
B.) At 50 lb. gage reading.. V = 1,023 ft./sec.

Critical Pressure

In the customary manner, the critical gage reading is determined as follows:

$$\frac{P_2}{P_1} = .53 \qquad (4)$$

$$P_1 = \frac{P_2}{.53} = \frac{14.7}{.53} = 27.8 \text{ lb./sq. in. abs.} \qquad (5)$$

$$27.8$$
$$-\ 14.7$$

Critical pressure = 13.1 lb. gage reading

Under the experimental conditions described, first visual observation of the phenomena was made at 20 lb. gage pressure (not at 13.1 lb.). This, how-

6. J. E. Ensweiler, *Thermodynamics*, p. 301. McGraw-Hill Book Co., 1937.

ever, was too faint for photography. At 20 lb., a thin continuous stream is observed to leave the throat. No separation into individual segments could be observed at 20 lb. pressure.

At higher pressures the air stream becomes more noticeable. Moreover, the higher the pressure the broader appears the picture of the air stream. Last but not least, with increased pressure the segments start to separate from each other more widely. The optical contrast seems to increase with increasing pressure.

In consideration of the fact that the critical pressure would be 13.1 lb. per sq. in. gage reading, it may be stated, therefore, that *the phenomena observed occur then if the velocity of air within the throat is of the magnitude of the velocity of sound in air* (1,100 ft. per sec.). To date, no flow patterns have been observed with this method at lower pressures and, therefore, at subsonic velocities of air.

While the above method is particularly applicable to the examination of air streams of the magnitude of the velocity of sound in air, or higher such as occur in projectiles, airplane parts, etc., it may be extended into the range of lower velocity by increasing the differences in the refractive indices of the air stream and the surrounding media. Such a change would occur if substantial temperature differences are existing between the temperature of the jet and that of the surrounding air.

Blowing of heated air (or of a different gas) into a cool medium or, inversely, the blowing of cool air in a heated medium, would offer facilities that should extend the method described into the range of lower pressures and thus subsonic velocities. In order to make visible phenomena below sound velocity and also in order to bring about stronger refractive and absorptive properties there may be used instead of air, as such, suspensions of smoke and fog in air. This includes the use of oil vapors and discharges of explosives.

In the critical examination of the above-given values, attention should be given to the fact that all formulas existing today are valid only for the velocity within the throat. They do not cover the velocity of gases after they have left the throat.

Yet there must be a difference in the relative velocities of air after the jet leaves the throat. This is necessary in order to explain the fact that there is more separation of the segments the higher the pressure of air used. Also the stream of air gets wider.

It should be noted in this connection that the gas densities are approximately equal to the inverse square of the flow velocity from small orifices. This was definitely established by Buckingham and Edwards.[7] Based upon this law is the Bunsen method for determining the density of gases. It should be given consideration in the further development of the formulas employed.

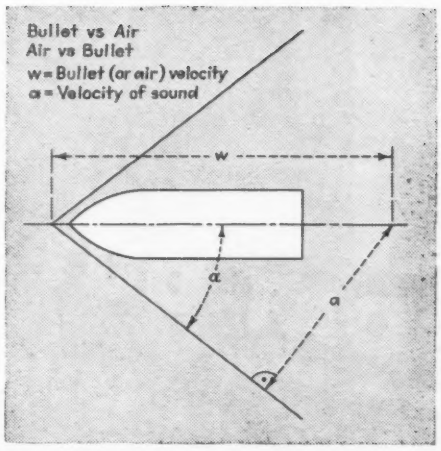


Fig. 11. Shockwave of a bullet.

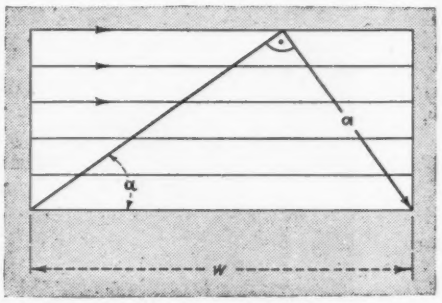


Fig. 12. Air traveling past an object.

The above-found values, therefore, shall be considered merely as giving the order of magnitude of the velocity with which we are dealing. In this instance, both pressures being above the critical pressure, the velocity within the throat or orifice may fairly be assumed to be near the velocity of sound at the given set of conditions of pressure and temperature. The calculated values, which are theoretically identical and 1,023 ft. per sec. in both instances, are close enough to the 1,100 ft. per sec. sound velocity for a first experimental and theoretical approach.

Effect of Broader Nozzles

In addition to photographs of comparatively narrow air jets, as such, pictures were also taken of broader nozzles. In order to make the latter ones, high pressure tubing was pressed flat between the clamps of a mechanic's vise. Studies of air streaming out from such a flat jet are seen in Figs. 6 and 7.

Fig. 6 shows air escaping from this flat rubber tube at high pressure and thus velocity. And Fig. 7 depicts air flowing at low velocity out of the broader rubber hose and impinging upon a glass plate inclined towards the direction of the jet.

7. Buckingham and Edwards, *Bulletin of Bureau of Standards*, 15, 573, 1920.

An airstream escaping a circular nozzle, as seen from the side, is shown in Fig. 8. Here, it is interesting to observe that the air stream hitting the plate is apparently of higher velocity than this part of the stream which leaves the plate. No serrations are visible in this latter part while the subdivisions in the first part, which is closely adjacent to the nozzle, are clearly visible. Air impinging upon glass plates develops interesting patterns upon these plates. These patterns are hardly visible in transmitted light but are noticeable in the projection of the plates upon the screen with the optical arrangement referred to previously. There exists the possibility that steam or oil vapor may have been retained in the pressure reservoir and that thin deposits of oil films have been made upon the glass plate.

Working Hypothesis for Optics

The experimentally established necessity for either a geometrical or an optical point source of light and the general arrangements in question bring about the probability that the observation of the phenomenon in question is essentially based upon differences in the refractive index within the space through which the cone of light has to pass previously to its falling upon the projection surface.

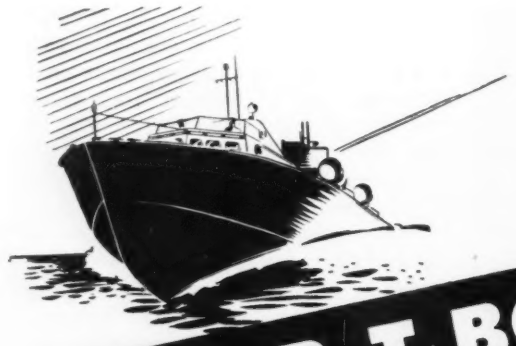
Generally speaking, it seems permissable to assume that this phenomenon can be observed only if the light comes from a point source whereby this point source can either be a geometrically obtained pinhole or an optically obtained concentration of a bundle of light into a smaller opening. This immediately impresses one with the similarity of this arrangement with the ones used in the study of interference phenomena.

No changes in the color were observed, only black and white phenomena. Direct observation of interference phenomena seems, therefore, not to have taken place at the phenomena under discussion. There is, however, good reason to assume a bending of the light rays. The reasons for this are twofold:

1. As can be seen clearly in Figs. 3, 4, 6, 7, and 8, a duplicate contour of the jet is visible. 2. The corners of the serrations appear round. According to the refraction formula mentioned under the subsequent Fig. 12, there should be sharp corners within the projection of the air jet, not round serrations. These differences against the theoretical straight line could be explained by a bending phenomenon.

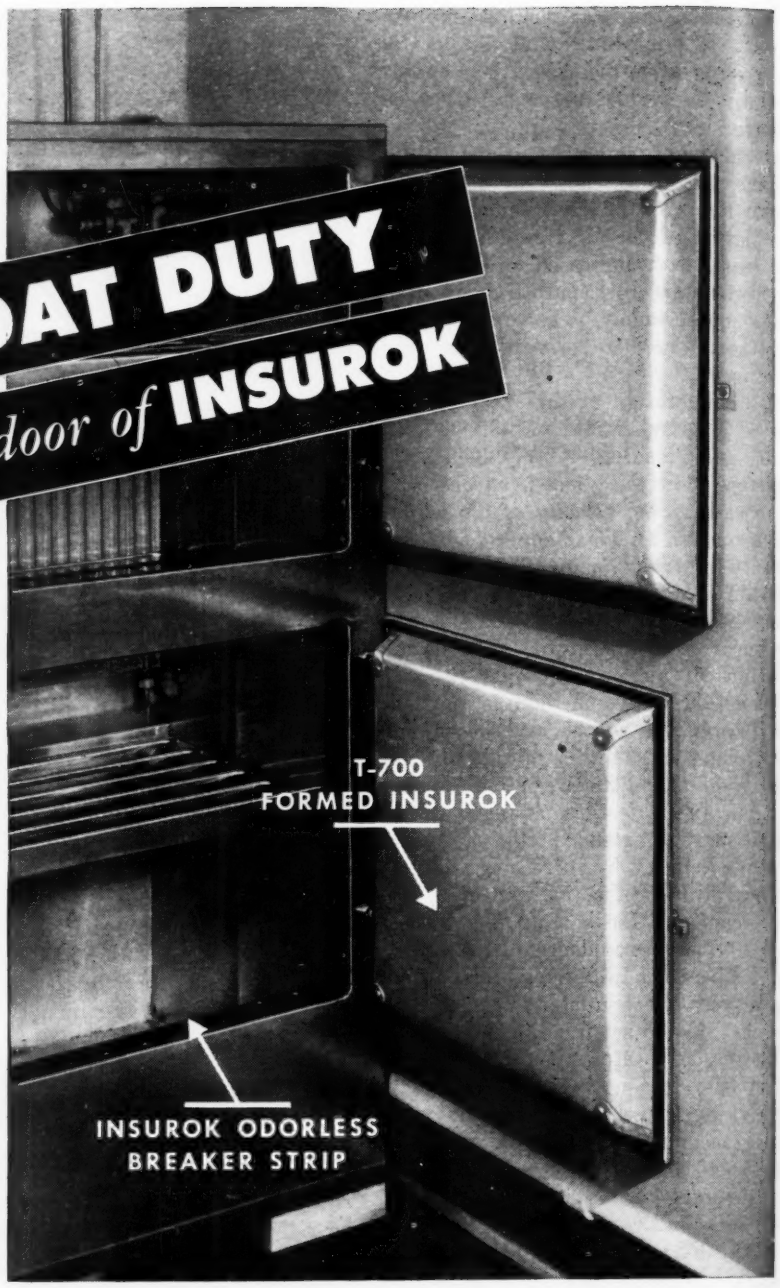
In consideration of the fact that *the density of the gas changes in the different parts of the jet, a refraction must take place* in the different areas. It seems permissible to assume that air

(*Turn to page* 326)



ON P-T BOAT DUTY

—Refrigerator inner-door of INSUROK



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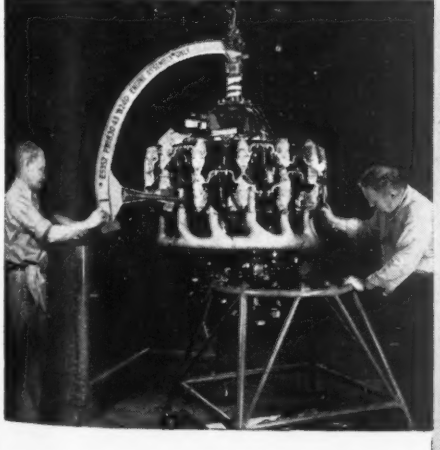
HELPING TO WRITE
THE STORY OF TOMORROW

CLEANING A MOTOR



MOTOR ASSEMBLY

MATING A WING

FIELD SERVICE

ROHR AIRCRAFT CORPORATION *CHULA VISTA, CALIFORNIA*

Photoprint Process Of Loft Layout Reproduction

By **FRANK B. MARSHALL,** *President, Photoprint Company*

Accurate transferral of master drawings in any quantity to any material is here accomplished by direct contact photographic reproduction, with no distortion of lines. Relatively low in cost, this method makes for great savings in time and labor, gives precise quantity tooling.

REPRODUCTION of mold loft layouts, drawings, and master boards without distortion of lines and with all data accurately transferred by some faster means than the laborious, time-consuming "lifting off the floor" by hand, has been a problem that has long challenged aircraft engineers.

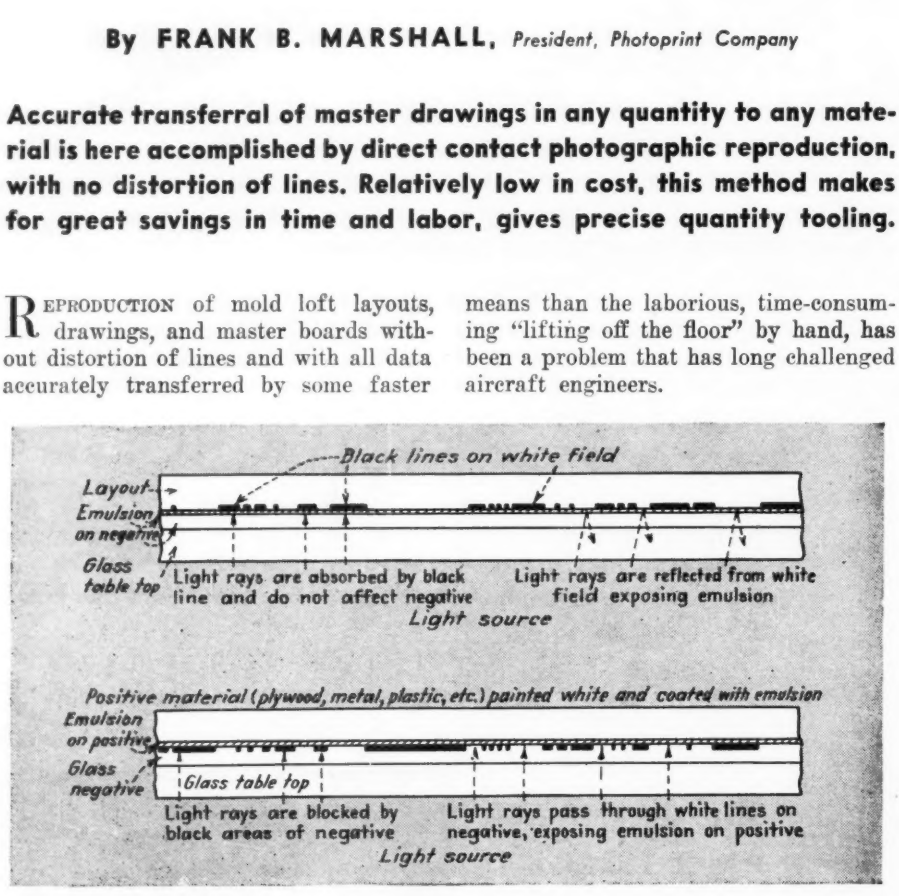

Black lines on white field
Layout
Emulsion on negative
Glass table top
Light rays are absorbed by black line and do not affect negative
Light rays are reflected from white field exposing emulsion
Light source
Positive material (plywood, metal, plastic, etc.) painted white and coated with emulsion
Emulsion on positive
Glass negative
Glass table top
Light rays are blocked by black areas of negative
Light rays pass through white lines on negative, exposing emulsion on positive
Light source

Fig. 1. Schematic diagram of (a) negative making, and (b) positive print making by the contact-printing reflection method employed in the Photoprint system of making line reproductions of loft layouts, drawings, templates, and other subjects.

Many methods have been devised, most of them excellent for one or more uses but definitely limited in scope of application because of high cost, possibility of error, or tendency to distortion of lines. X-ray, photographic, and printing processes have been the basis of most of the methods developed to date.

A new method, based on the direct or contact-printing portion of the photographic process, is now finding increasing uses by concerns in the aircraft and component fields, including Consolidated, Douglas, Interstate, Ryan, Brewster, Briggs, Fleetwings, General Motors, Goodyear, and Vought-Sikorsky.

Known as the Photoprint process, it incorporates the Taber-Van Dusen method of direct contact of the subject under pressure with the sensitized surface of the material upon which it is to be reproduced. The resulting reproduction is undistorted and includes all data exactly as it appeared on the original. Any desired quantity of duplicates (including left- and right-hand prints from the same original) can be made upon rigid sheets or blocks of metal, plywood, hard wood, plastic, or other material.

Products of the process are full-scale line reproductions of any original, layout, drawing, template, etc., on sheets of any desired rigid material, or upon

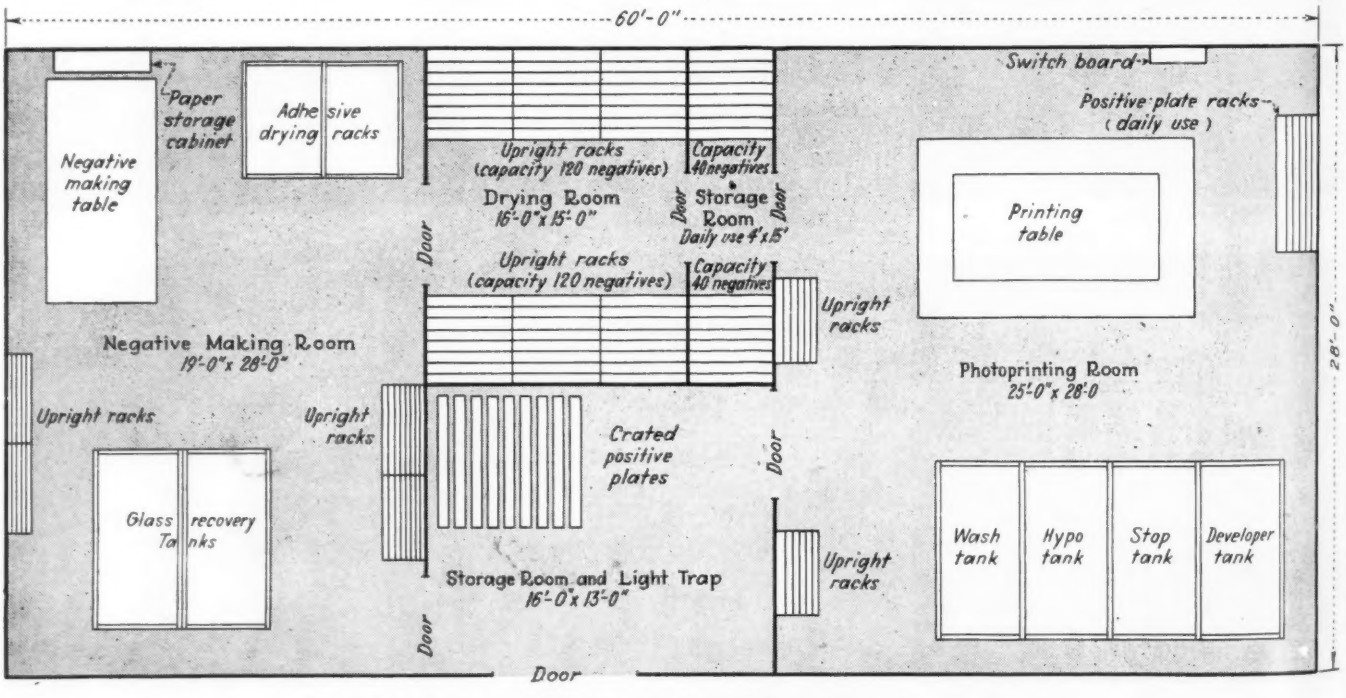


Fig. 2. Typical arrangement of photoprinting department as used by several aircraft manufacturers. Several installations are much larger than this.

paper or linen for blueprinting. Being a direct-contact reproduction, positive accuracy is achieved and broadening of lines is eliminated. Dimensional stability of the original is preserved, the possibility of human error avoided, and slow, expensive hand-copying is replaced by a quick, inexpensive process.

Supervisors can be trained in the operating technique in a comparatively short time, and their assistants do not need to be highly skilled.

The process is photographic in that it involves sensitized negative and positive materials, exposure of these to light, and subsequent treatment in chemical baths to develop and fix the image. It differs from conventional photography in that no camera or lens is used. Instead, the negative is made by placing its emulsion side in direct contact with the surface of the original layout, template, or other subject, and passing light through the negative (Fig. 1).

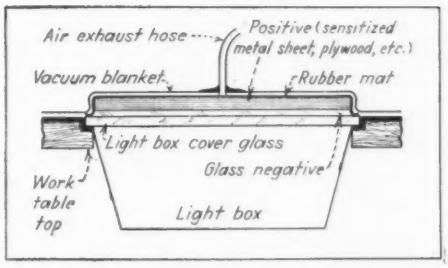


Fig. 3. Cross section of photoprint printing table, showing order in which negative and positive materials are placed over light box.

This is reflection printing and is based upon the principle that light is absorbed by the dark surfaces (lines) and reflected by the light surfaces (background or field) of the subject. The positive print is made from the negative, the same as photographic contact prints are made from film negatives.

Equipment required is easily built (requiring very little strategic materials and only ordinary carpentry), to provide a dark room arranged into three main departments. They are (1) Negative making room, (2) Photoprinting room, (3) Drying room. In the negative making room are light-proof paper storage cabinets, a large table, adhesive drying racks, glass-recovery tanks, and upright racks for glass-plate storage. Across the center of the Photoprint department are storage rooms and light trap on one side and upright drying room racks on the other (Fig. 2).

Largest of the three sections is the Photoprinting room, recommended size of which is 25 ft. x 28 ft. for the average volume of work to be done. In it is a large printing table with a light source below its center section, covered with a thick plate of diffusing glass (Fig. 3). A rubber mat, or vacuum blanket, is arranged so it can be unrolled to cover this printing table com-

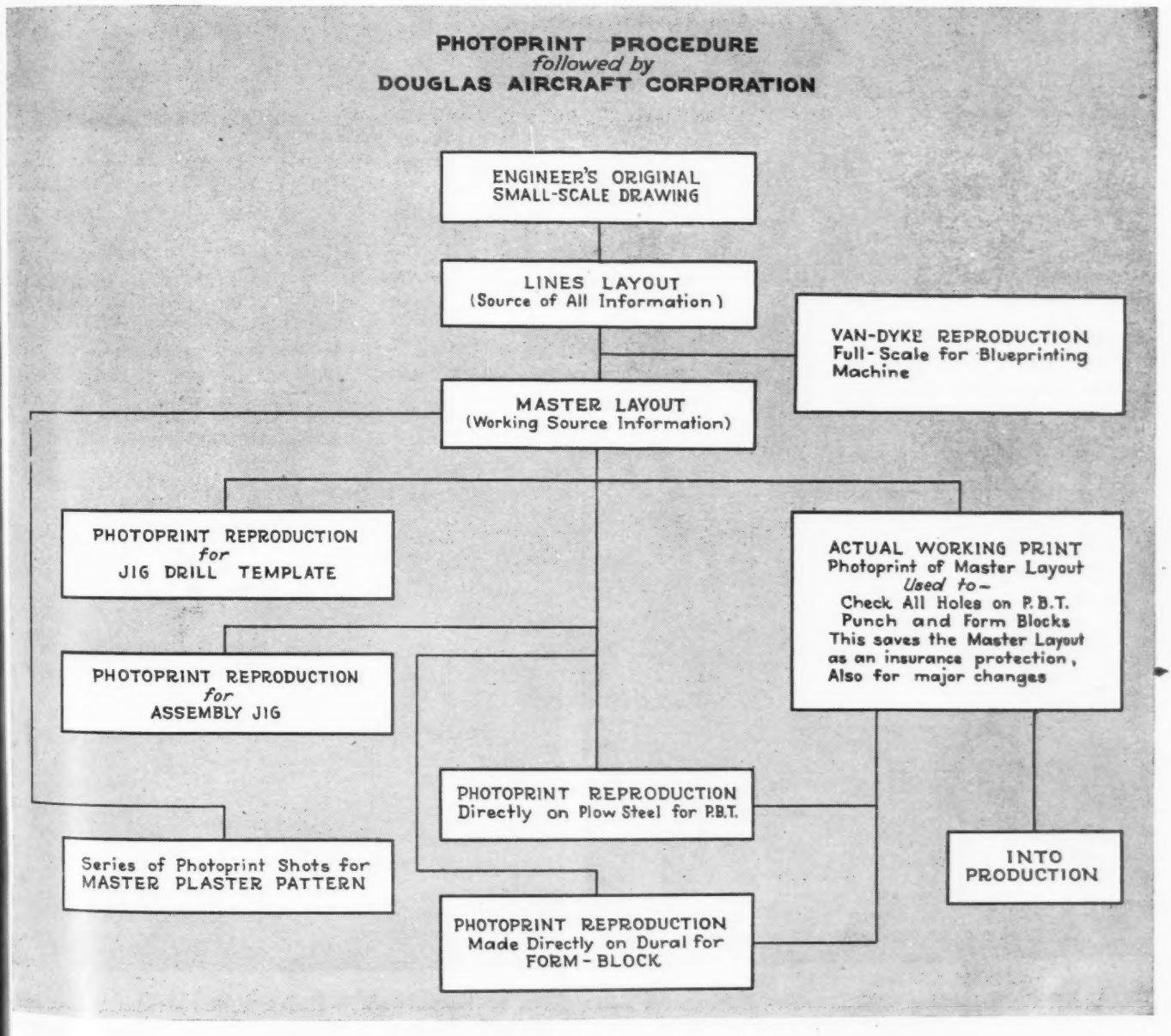

PHOTOPRINT PROCEDURE
followed by
DOUGLAS AIRCRAFT CORPORATION
ENGINEER'S ORIGINAL SMALL-SCALE DRAWING
LINES LAYOUT (Source of All Information)
VAN-DYKE REPRODUCTION Full-Scale for Blueprinting Machine
MASTER LAYOUT (Working Source Information)
PHOTOPRINT REPRODUCTION for JIG DRILL TEMPLATE
ACTUAL WORKING PRINT Photoprint of Master Layout Used to— Check All Holes on P.B.T. Punch and Form Blocks This saves the Master Layout as an insurance protection, Also for major changes
PHOTOPRINT REPRODUCTION for ASSEMBLY JIG
PHOTOPRINT REPRODUCTION Directly on Plow Steel for P.B.T.
Series of Photoprint Shots for MASTER PLASTER PATTERN
INTO PRODUCTION
PHOTOPRINT REPRODUCTION Made Directly on Dural for FORM-BLOCK

Fig. 4. Chart showing various uses made of photoprints in tooling department of Douglas Aircraft Co.'s El Segundo plant.

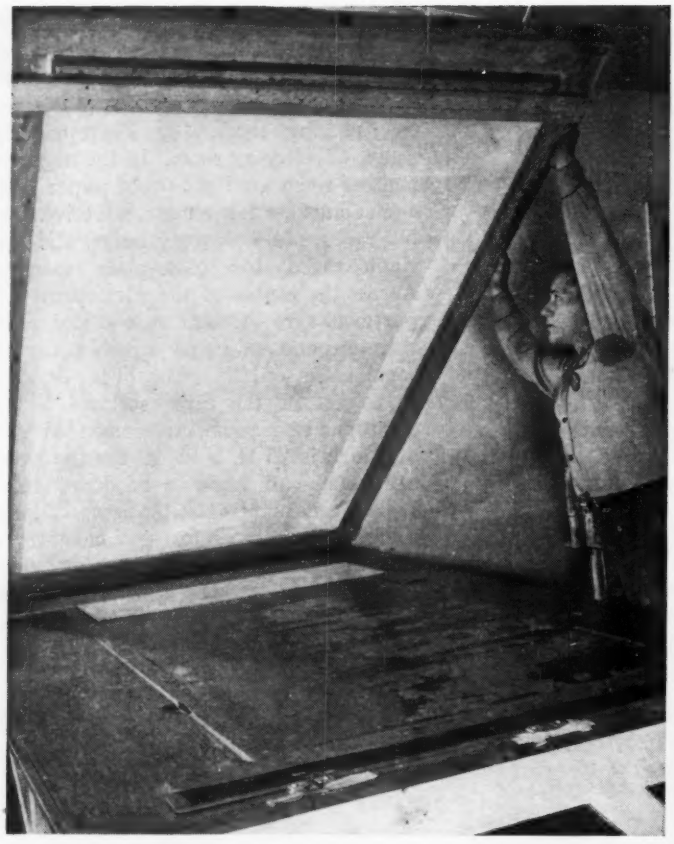


Fig. 5. In photoprint process, silk screen is used to apply paper-adhering adhesive to glass negative, to coat positive material with light sensitive emulsion, and to cover positive material with a smooth coat of paint of uniform thickness. (This photo and those in following six figures by Consolidated Aircraft Corp.)

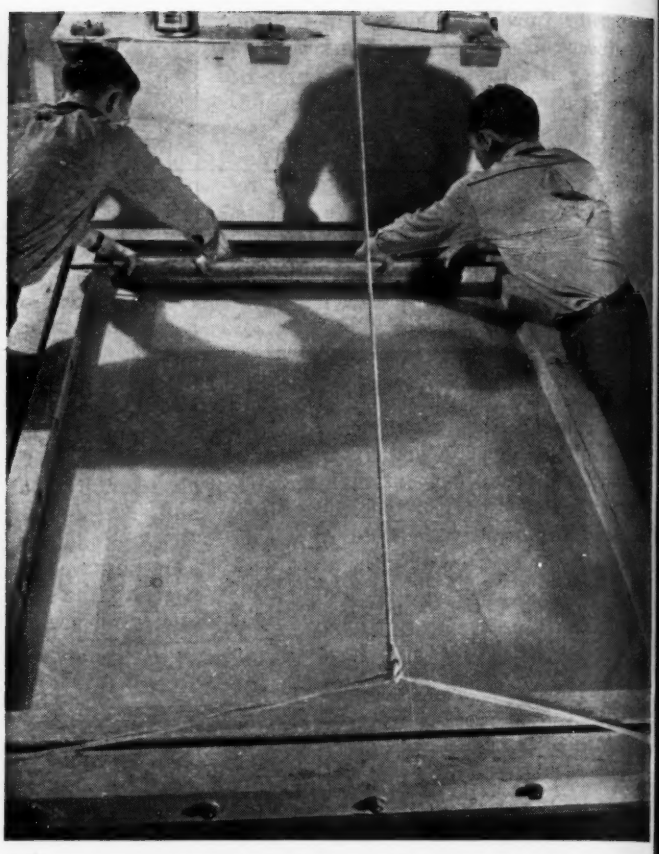


Fig. 6. Adhesive, sensitizing emulsion, or paint are forced through silk screen onto surface to be coated with a rubber squeegee.

pletely during printing. A hose connected to a motor-driven pump removes air and creates a vacuum under the rubber blanket, thus putting great pressure on the negative and subject.

An estimate based upon installations now in use puts the entire equipment cost at less than $3,000 and required floor space at less than 1,700 sq. ft., for a department large enough to produce all the Photoprints used by an average size plant. Some of the larger users, however, have installed departments costing several times that amount in order to produce exceptionally large quantities of the prints.

The negative plate is crystal glass $\frac{3}{32}$ in. thick to which has been adhered a sheet of sensitized translucent paper. Adhering the paper to the glass is a simple, speedy operation. Perfect adhesion is secured through use of a clear adhesive which is not affected by water or the developing solutions and does not allow the paper to shrink, stretch, or shift. This negative is rigid, and it produces an undistorted copy of the

Fig. 7. Sensitized paper is applied to adhesive-coated glass plate in this manner, using a special mandrel which permits maintenance of even tension on paper roll. Complete adhesion and freedom from wrinkles are essential.

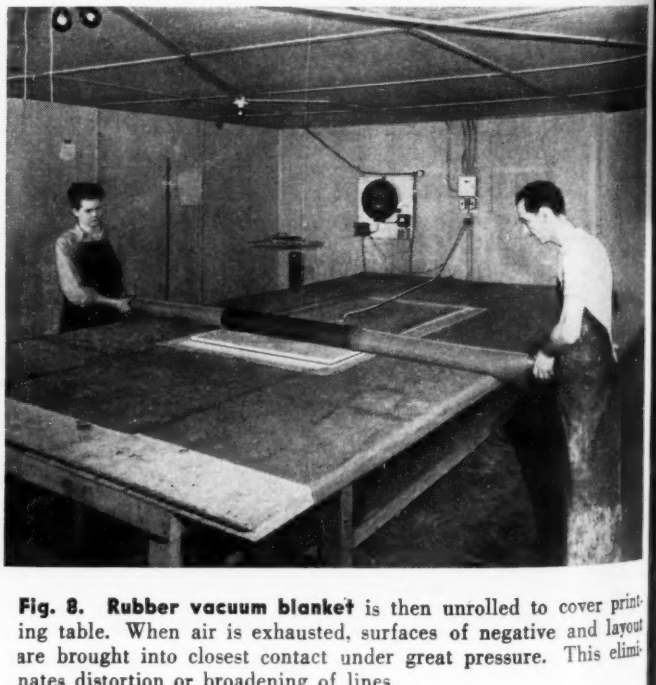


Fig. 8. Rubber vacuum blanket is then unrolled to cover printing table. When air is exhausted, surfaces of negative and layout are brought into closest contact under great pressure. This eliminates distortion or broadening of lines.

PERFORMANCE CONTROLS THE AIR

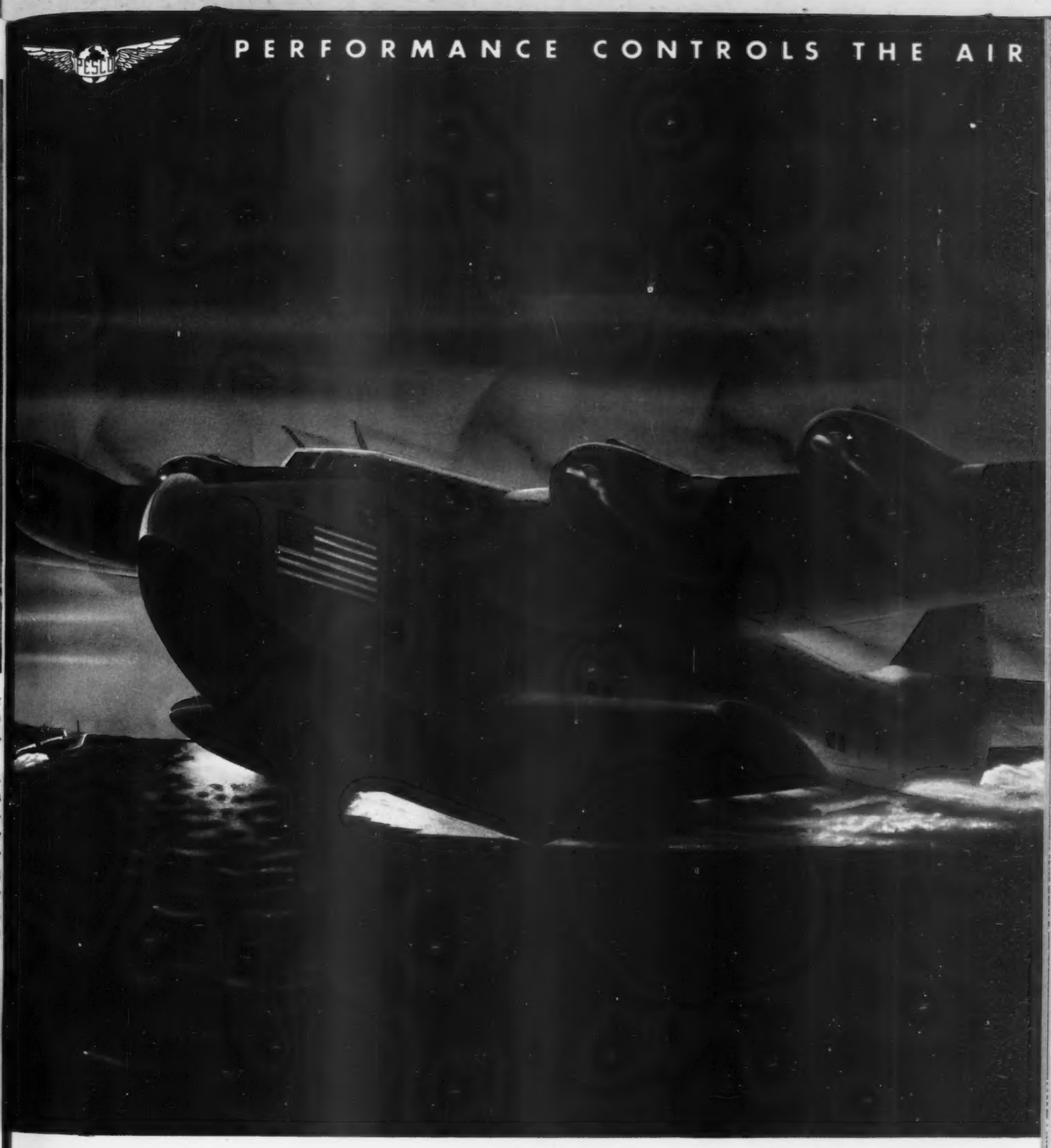


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Fig. 9. Light box under photoprint table contains a multitude of evenly spaced globes. Light is evenly diffused by a plate of ground glass set into table. Exposure is controlled by automatic timer.

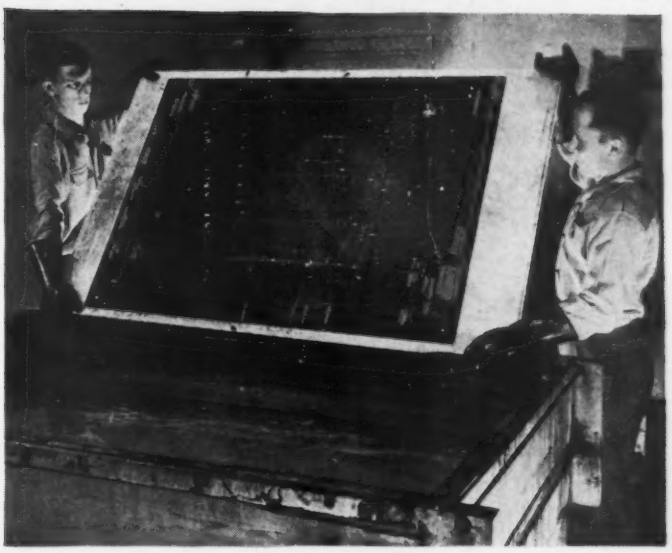


Fig. 10. Removing exposed negative from developing tank. Both negative and positive photoprints are developed and washed in same manner as in ordinary photographic printing.

original in reverse—that is, white lines on a black field. After use, the paper is removed from the glass easily with a solvent so the glass can be used repeatedly.

Any suitable or desired rigid material can be sensitized to form the positive plate. When plywood is used, it is first dipped in a waterproofing resin bath to protect it from the developing and washing solutions, then is smoothly coated with flat white paint, squeegeed on through a silk screen, on the side to be sensitized. Metal sheets also are painted in this manner before sensitizing. The white paint assures excellent contrast with the black lines of the finished Photoprint and provides a good, smooth surface for drawing with pencil, ink, silver stylus, or scribe. The paint and emulsion of the Photoprint lines do not chip away or burn and discolor during cutting, punching, drilling, and bending operations.

Procedure followed by Douglas Aircraft Co. (shown in chart form in Fig. 4), indicates the many uses of Photoprints in tooling. Photoprint reproductions of the master layout are made upon various material and from them are produced the jig drill template, assembly jigs, master plaster patterns, form blocks, and piercing blanking templates. While dural is shown as the material from which form blocks are made, other users of this process employ hard wood in many cases.

A feature of the greatest importance in the Photoprint method of reproduc-

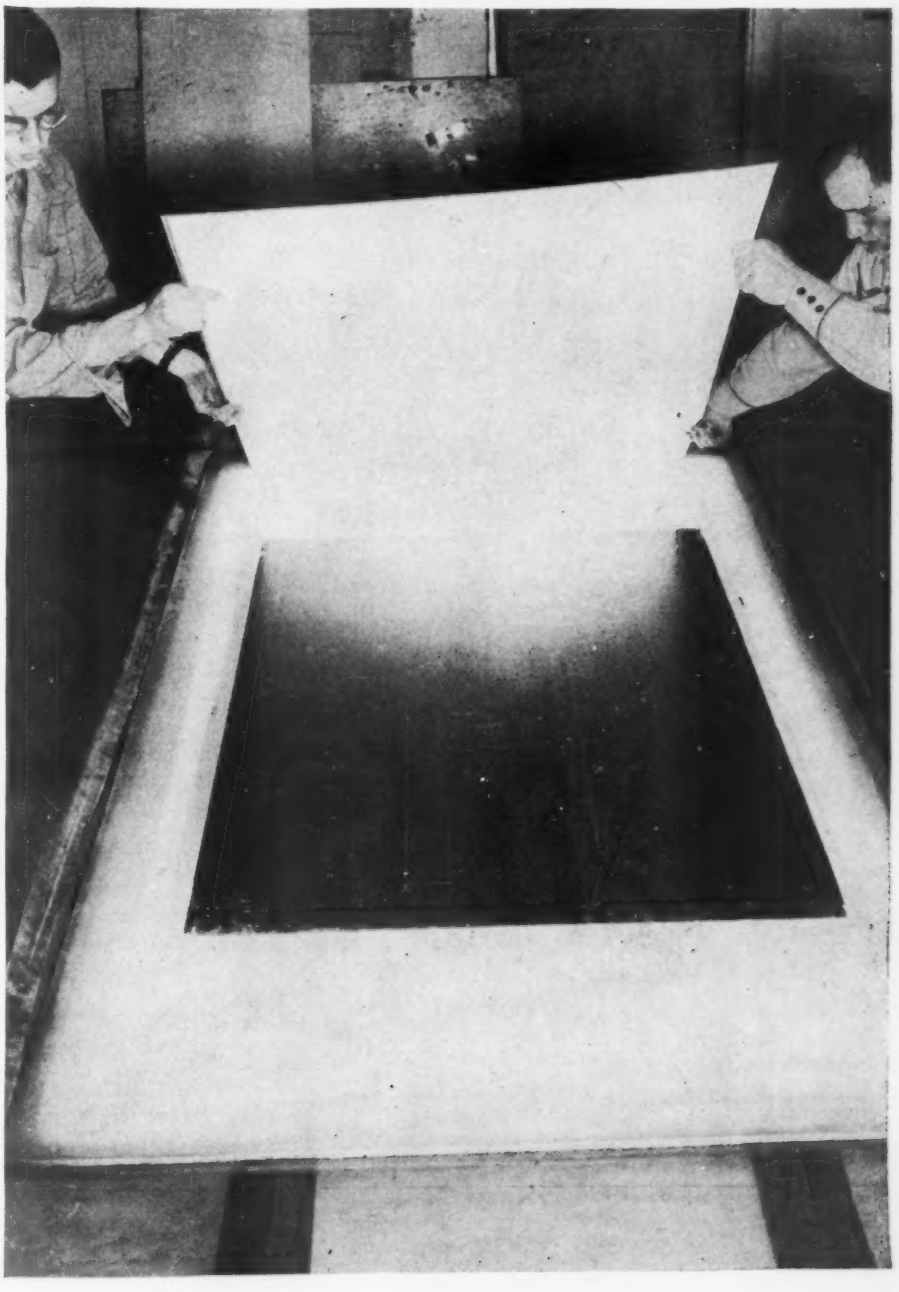


Fig. 11. Finished negative is here shown over light box while a sheet of sensitized metal is laid upon it for making a positive photoprint. In actual practice, this step is done with only red (safe) light of dark room lighted.

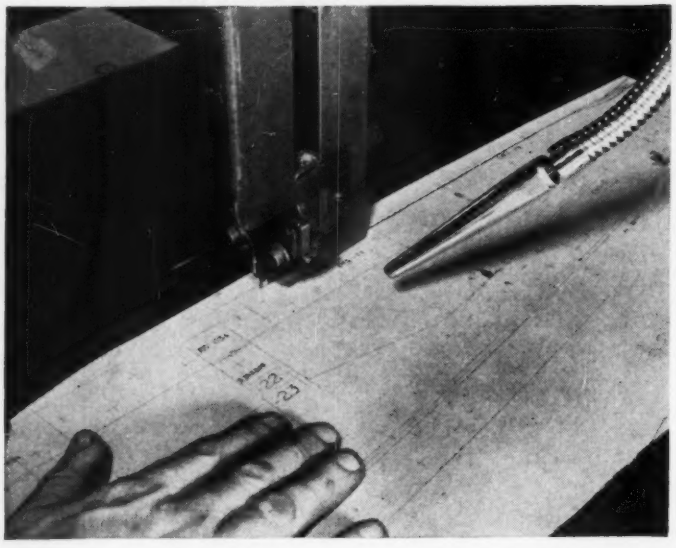


Fig. 12. Here, Photoprint reproduction of a scribed template is being cut out. Note that all data is reproduced on print. A special paint and emulsion which does not chip away, burn or discolor in cutting is used to coat positive material. (This photo and those in remaining eight figures by Douglas Aircraft Co.)

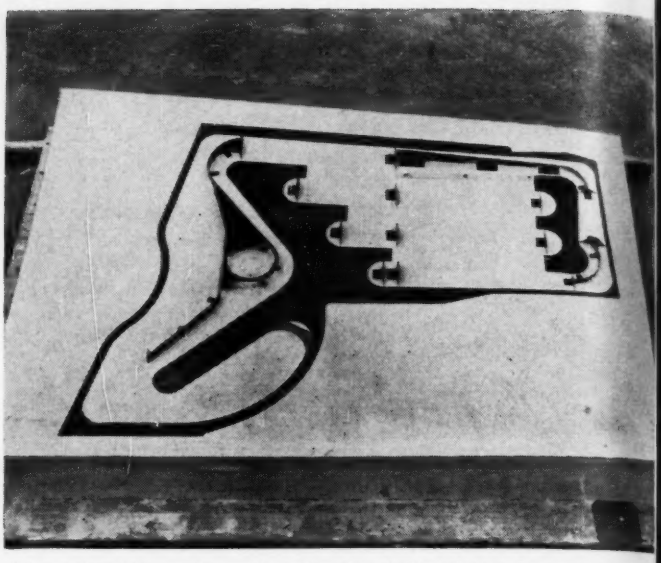


Fig. 13. Elements cut out of photoprints (except vertical locating stiffeners) are here being positioned on an over-all assembly photoprint in preparation for building up a master plaster pattern. This assures exact positioning and eliminates manual layout.

Fig. 14. Building up master plaster pattern. Even scrape templates used to shape contours are made by cutting out photoprints.

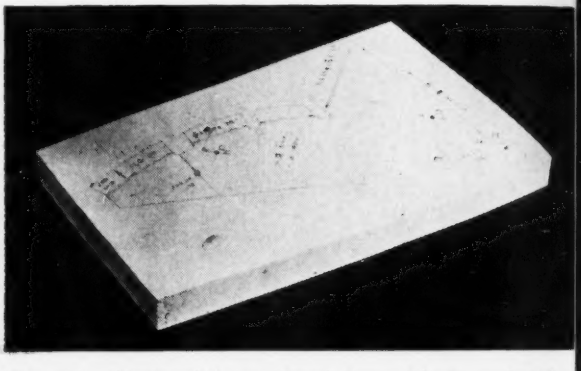


Fig. 15. Photoprint on dural form block material as used by Douglas Aircraft Co. Form blocks can also be of wood or other material. Note that all data and hole locations are shown.

tion is the ability to work directly from the master layout of the production tool. This saves many hours of work and conserves much material. To assure the correctness of the production tools, an over-all reproduction of the master layout is made, and the production tools are checked against this Photoprint. This reproduction is known as the "actual working print". Its use in the shop prevents damage to the original master layout and permits changes to be made on the latter. When changes are made in the original, the old working print is discarded and replaced by a new reproduction.

Reproduction of lines and data by

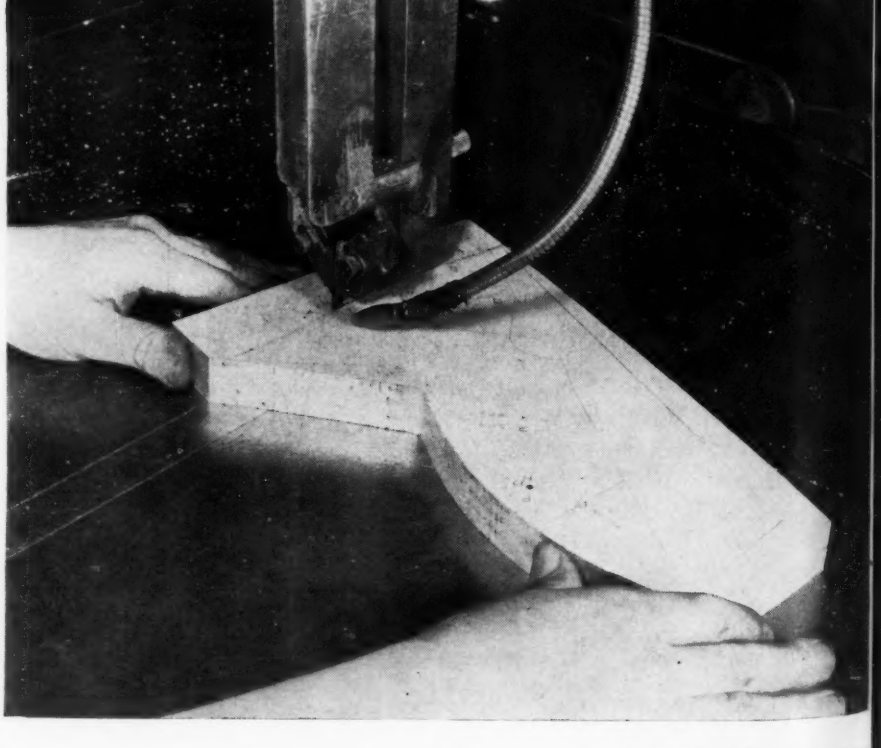


Fig. 16. Cutting out form block.

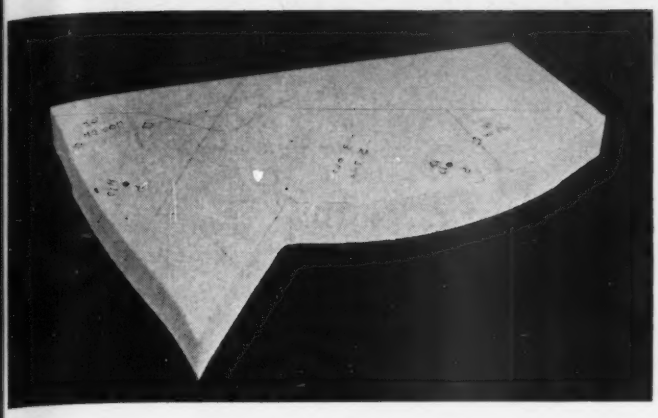


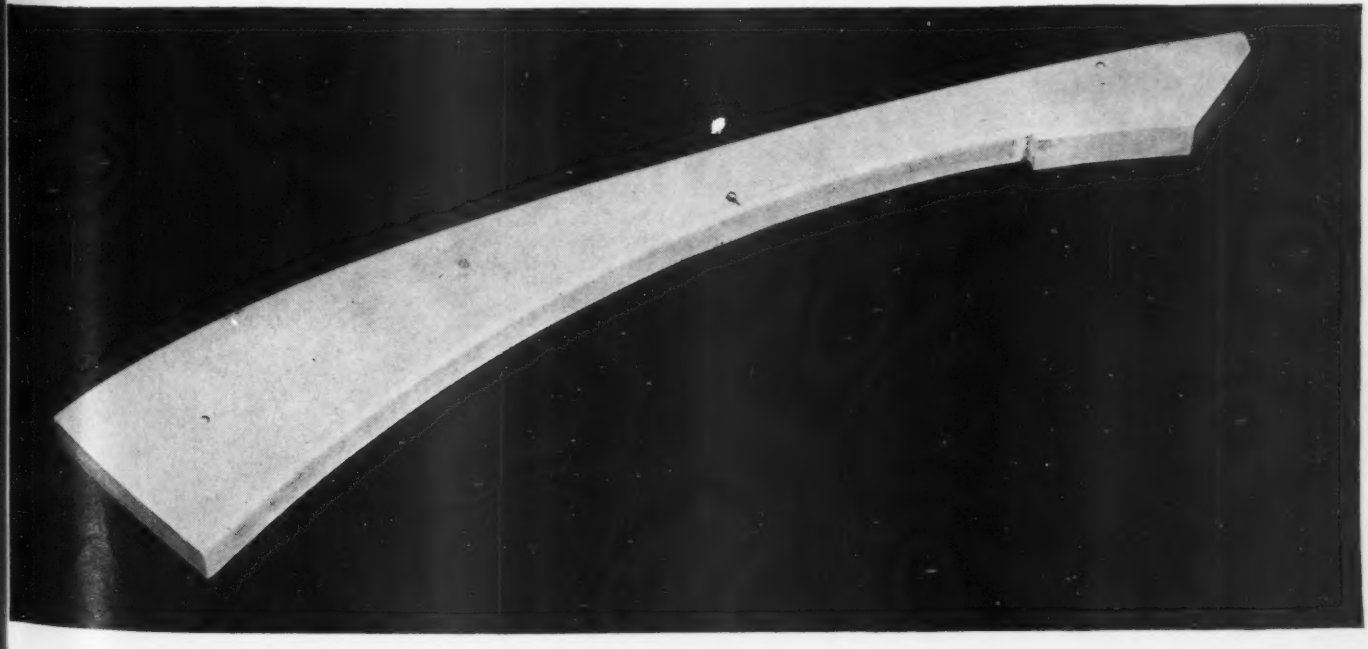
Fig. 17. Form block cut out, ready for finishing and mounting of location pins.

Fig. 19. Checking finished form block against a Photoprint of original lines layout. This Photoprint is used as actual working print, and its use in shop prevents damage to original layout.

Fig. 18. Finishing a dural form block made from a Photoprinted block of metal.

photoprinting directly upon sensitized form block material eliminates the need for a form block template, as all information appears on the form block itself and the correctness of the shape is insured. Also, both reproductions shown and opposite reproductions can be made on form block material from a single-hand original. Having the image and data on the form block facilitates checking it with the actual working print, since the two images can be placed in actual contact and quickly compared, regardless of open or closed bevels.

Fig. 20. Finished dural form block, ready for production run.



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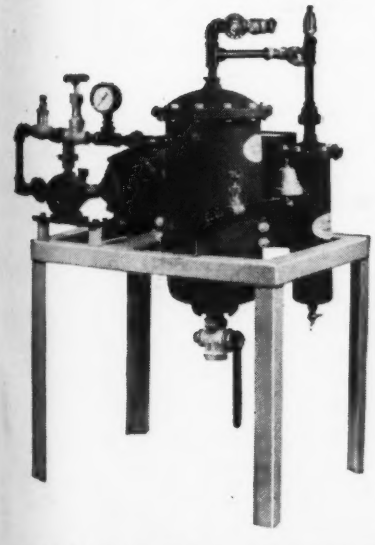

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Design Considerations For Plywood Structures

Part IV . . . Wings

By **L. J. MARHOEFER,** *Chief Engineer, Vidal Research Corporation*

Advancing beyond primary considerations of weight saving, this cogent discussion of innovations in wing design gives attention to economy in both materials and labor . . . Fourth in the author's salient series on basic factors in the design of plywood aircraft structures.

Tracing the development of aircraft wing structure design from the time of Chanute to the present, it is apparent that the current system of rib-spar grills was fathered by Chanute and has subsequently been subjected to a series of refinements and modifications as materials and wing sections have been improved.

Originally a simple framework over which fabric could be stretched taut, it lent itself readily to design approximations of accuracy equal to the then-current knowledge of aerodynamics and air forces, and it was relatively simple to construct when the final surface was fabric.

Necessity of more substantial covers has been dictated by our higher speeds, resulting in the use of metal and plywood skins. Aerodynamic refinement has required the present smoothness and flush-rivetted joints, with a minimum of wrinkling and buckling during normal service operations. The study of buckling phenomena in metal sheet has led, in turn, to the use of closely spaced stringers and supporting ribs and has increased constructional difficulties. No disparagement of the ingenuity and care of the designers is possible in view of the fact that while wing loadings vary from 6 to 35 lb. per sq. ft., the wing weights vary from 1.5 to 3.5 lb. per sq. ft. The additional care in design with increasing loading is obvious.

Refinement of design has led to a practice, in metal structures, of using thin sheets with large numbers of small stiffeners. The resulting increased labor required for assembling becomes of increasing importance at times when manpower shortages plague the industry. In more normal times the increased use of aircraft dictates the necessity of reducing the cost.

Examining the detailed reasons for the cost of the rib-spar grill with metal or plywood cover, the following considerations immediately present themselves:

1. Number of different parts requiring separate tools and manufacturing facilities.
2. Close tolerances necessary on each part in order to permit assembly.
3. Cost of assembling grill system.
4. Inaccessible joints necessary when structure is closed with metal cover.
5. Large numbers of rivets required.

The above is by no means a complete list, but it illustrates the outstanding bars to the path toward reduced labor hours for an assembled wing. That at least examination of the possibilities of reduction is advisable is brought out by the fact that labor per pound of material runs in the neighborhood of 5 hr. on modern aircraft as compared with automobiles at 0.17 hr./lb. Reduction in any of the listed factors will be promptly reflected in increased production and lower labor requirements.

Simplified Molded Structures

Recognizing that major changes in methods and arrangements are most readily accomplished simultaneously with the introduction of new processes and materials, a sincere effort has been made not only to devise structural arrangements adapted to molded plywood but to develop simplified assemblies. Some encouragement toward changing the structural arrangements was afforded by the early wing structure tests, results of which were anything but cheering. The first serious efforts toward wing design were guided by the then-popular metal structures, consisting of a single box type strength member with attached leading edge and trailing edge fairing pieces which incorporated chord-wise ribs (see Fig. 1).

Each of the three pieces was molded into a portion of the structure with its frames, ribs, and stiffeners integral. The ribs themselves were molded and then held together as an assembled unit by molding the wing skin into place. The beam portion of this wing was a plate-stringer box combination with varying skin thickness, molded in attachment pads with a goodly amount of "blood, sweat and tears." When it got down to actual static tests, some pause for reflection was occasioned.

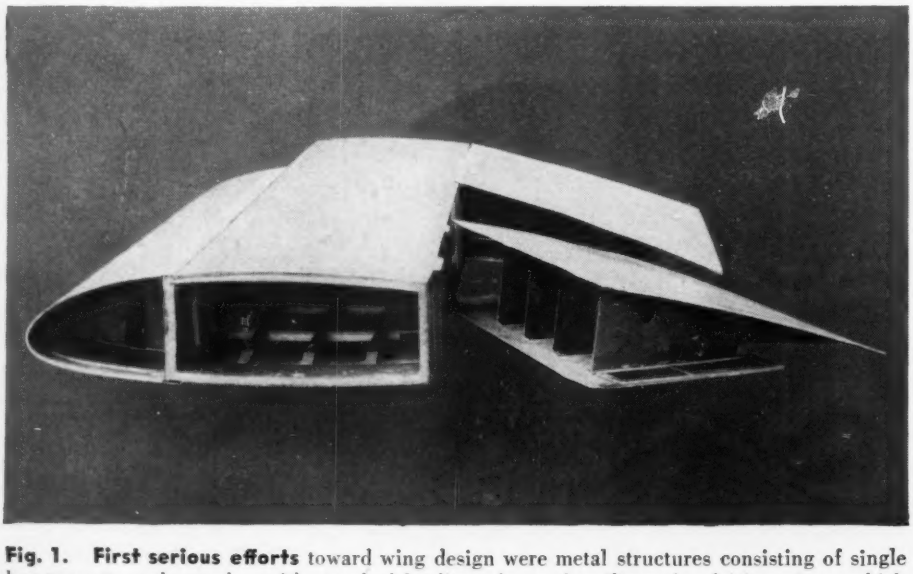


Fig. 1. First serious efforts toward wing design were metal structures consisting of single box type strength member with attached leading edge and trailing edge fairing pieces which incorporated chord-wise ribs.

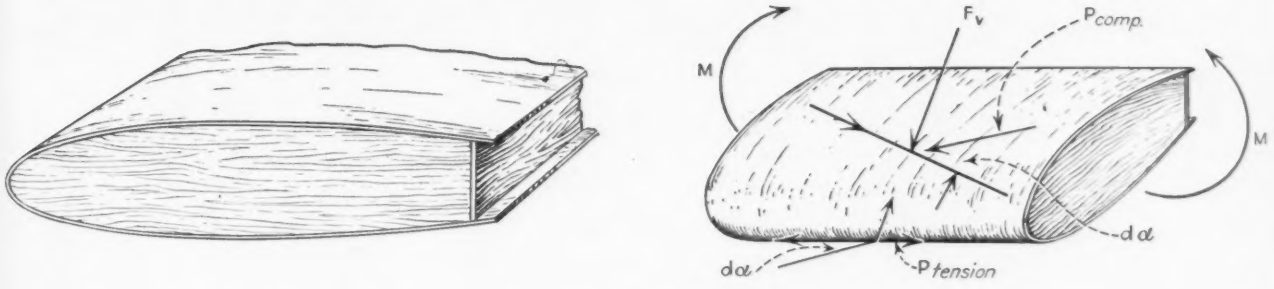


Fig. 2. (left) Consideration was given to feasibility of using forward shear web as a leading edge, and wing at this stage of design was then hollow tube as shown. Fig. 2a. (right) designates the factors.

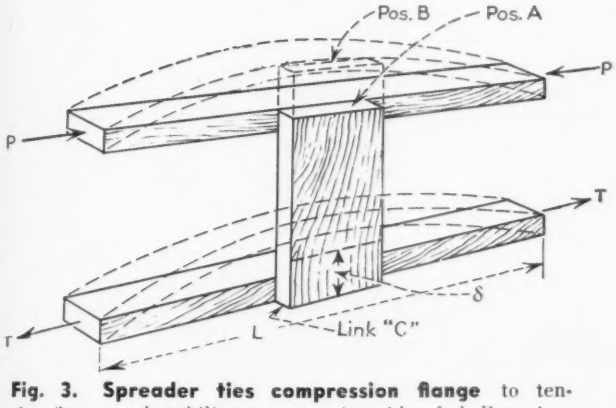


Fig. 3. Spreader ties compression flange to tension flange and stabilizes compression side of shell against buckling locally or as a whole. Depicted are two members, one loaded in compression, other in tension. With employment of link "C", restraining force developed tends to hold member straight (see article).

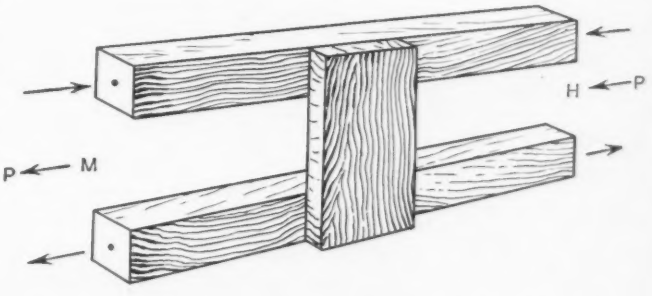


Fig. 4. With biplane wing, forces were reduceable to this system of a couple accompanied by a compressive force. Theory of existence of tension stress being borne out, stabilizing tie functioned satisfactorily.

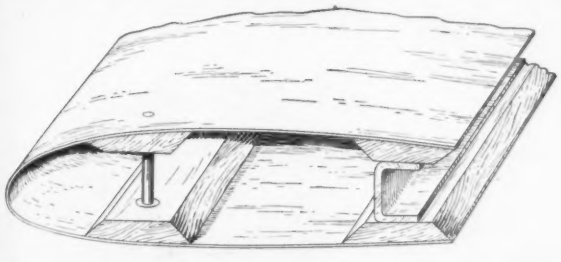
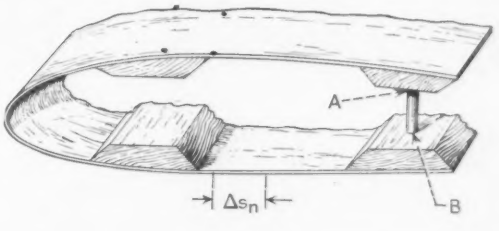


Fig. 5. Consideration of Dee-spar wing. All parts are subject to rational design, with exception of required bending strength and rigidity of skin about its span axis.



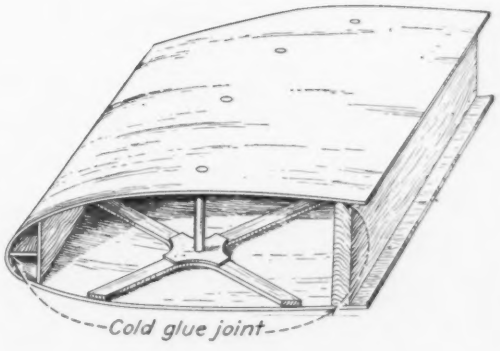
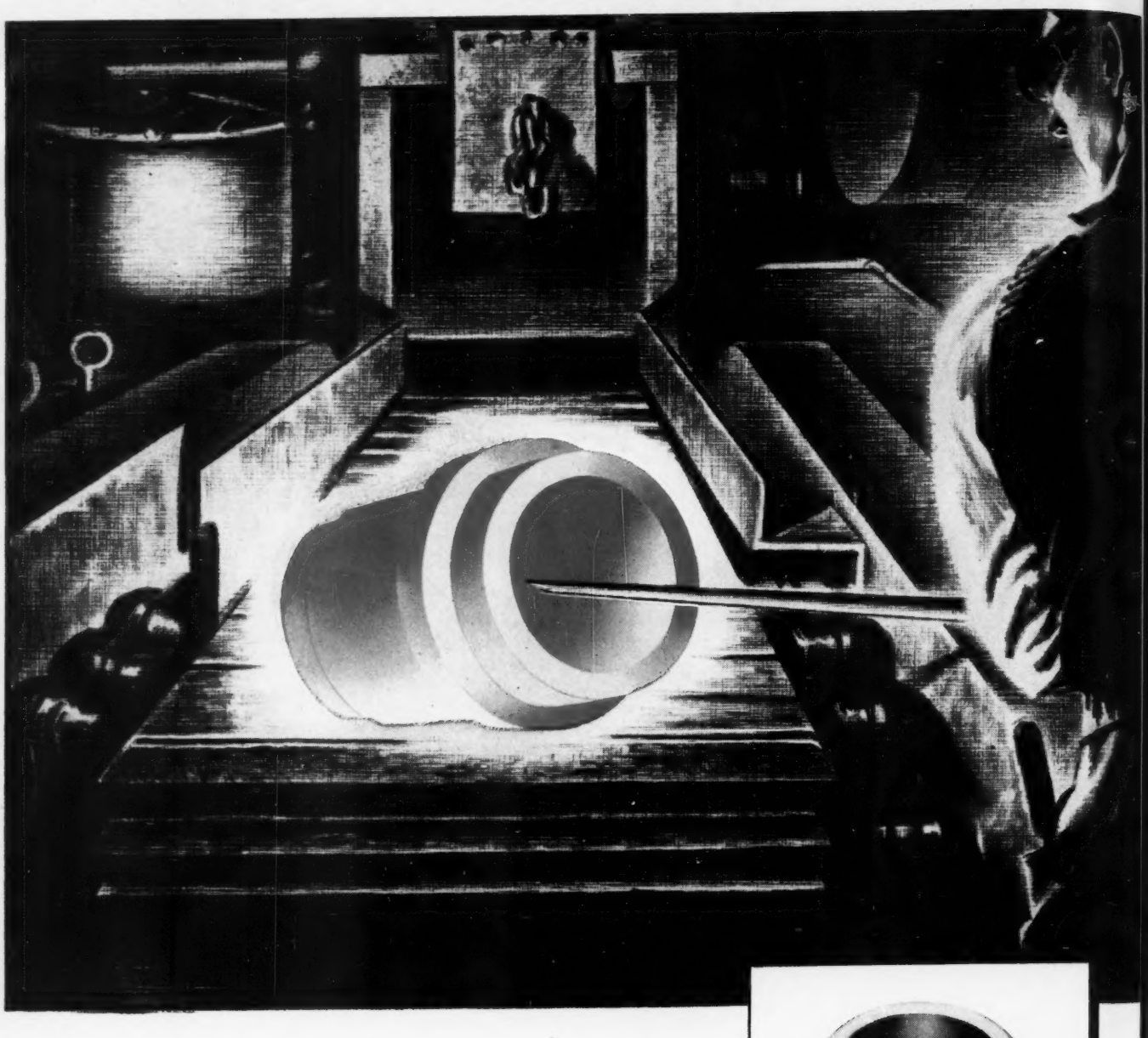


Fig. 6. (right above) Spanwise section of wing with rear web cut at "A." Fig. 6a. (right) Typical stabilizer construction on single form and molded complete with stiffeners and half leading edge.

During this pause it was possible to view the matter in retrospect and to realize that no matter how simply parts might be constructed, the number of parts made a definite and unavoidable contribution to the cost of the final piece. It was also of note that joints and fittings could readily be as expensive as the parts being joined.

Carried to its extreme of simplification, the least expensive wing structure would be a poured material permitted to solidify in a permanent mold in which all fittings are reduced to a minimum and those determined as unavoidable held in position until the poured material solidified and anchored them in place.



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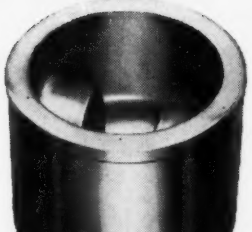

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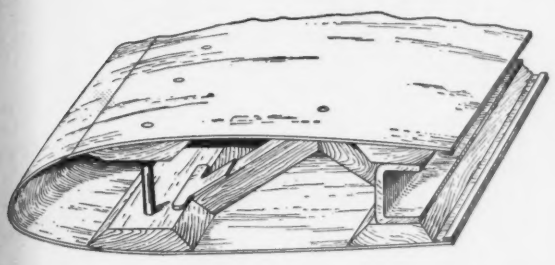

Fig. 7. Early wing construction. Molded from forward flange to flap/aileron cut-off.

Fig. 8. Intermediate construction shown here is similar to that in Fig. 7, except that flanges are wide and molded to contour.

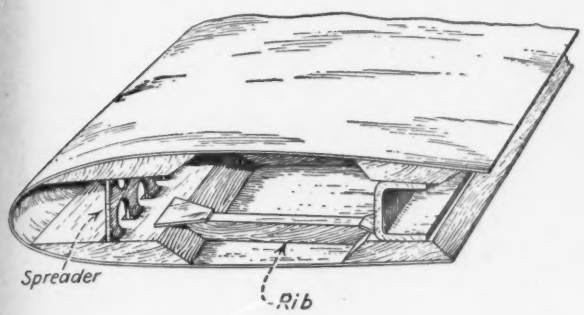

Fig. 9. Here, outer shell, molded on an "inside" form, is complete in one operation.

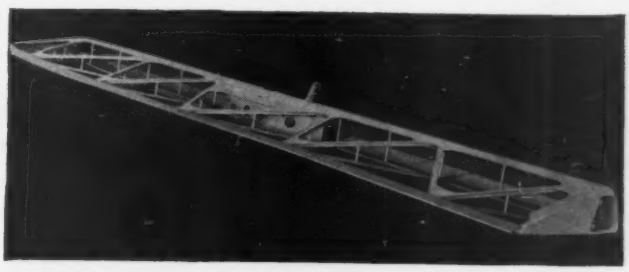

Fig. 10. Aileron skeleton for fabric-covered trailing edge. Spacers replace web.

Beam Web and Rib Functions

But structural material at hand being unpourable and in addition too dense to permit use of a solid wing, we turned next to examination of the functions of the rib webs and spar webs with a view to their replacement or elimination. Rib webs are installed to maintain the surface contour, transmit the local air loads to the main structural members, and, redundantly, serve to resist the torsion. In a monocoque shell these webs perform the additional function of acting as support members resisting the tendency of the tension and compression flange material to draw together.

Elimination of either the rib web or the beam webs offered a possible simplification not confined merely to the elimination of the parts themselves. The connection of the rib and beam webs presents a construction problem which adds in no small measure to the cost of the wing, and any feasible method of reducing or simplifying the crossing of two webs is in itself worthwhile. The forward spar web in a two-spar wing, when considered as a shear flow path, is redundant with the continuous nose shell.

Having observed that for practical wings it was not normally feasible to construct a sufficiently thin web to achieve buckling throughout its length, consideration was given to the feasibility of using the forward shear web as a leading edge. The wing at this stage of the design was then a hollow tube as shown in Fig. 2.

It was possible to rationalize sizes for all parts, with the exception of the shell thickness necessary to resist local distortion due to local air loads and wing deflection. The latter load being, in general, equal and opposite on the tension and compression sides of the shell, any spreader would serve the function of providing a complete flow path. The problem of column buckling of the compression material was also answered by the spreader.

Compression Flange Buckling

Stabilization of the compression side of the shell against buckling locally or as a whole is provided by this same spreader. The certainty that tieing the compression flange to the tension flange would provide such stability has been proven by test and is rationalized on the following basis:

Let us consider two members such as depicted in Fig. 3, the one loaded in compression and the other in tension. In order for the compression strut to fail as a column it must displace from position "A" to position "B". If the center of the two members are connected by a link "C," the tension strut will then experience a force tending to draw it from its normal position and a restraining force will develop due to the tension loads "T" tending to hold the member straight. Evaluation of this restraining force is a mathematical problem of some magnitude, since it is a function of the buckling flange. Fortunately, in the case under consideration it has not been of sufficient magnitude to cause trouble and the design of the ties to carry the locally applied loads has provided sufficient strength for the buckling tie as well.

Re the Biplane Wing

A biplane wing cell constructed on this theory has provided evidence that this principal of stabilizing the compression flange by tieing it to the tension flange is true, even though only a differential compression exists on the two flanges. In this instance, due to the external brace wires, the loads on the portion of the wing shell in the bay were all of compression and bending type, with the bending moments of insufficient magnitude to produce resultant tension stresses. It was possible to rationalize that the forces were reduceable to a system (Fig. 4) consisting of a couple accompanied by a compressive force and that because of the existence of the theoretical tension stress the stabilizing tie would function. This theory was borne out adequately, and, it must be confessed, surprisingly, by the first test of the cell.

Shear Stress Computation

Returning to the wing shell (Fig. 5) it is apparent that all parts are subject to rational design, with the exception

(*Turn to page* 360)

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Theory and Technique Of Perspective Projection*

Part III

By **GEORGE F. BUSH,** *Assistant Professor of Graphics, Princeton University*

Increasingly favored on aircraft production lines, perspective engineering illustrations are both supplementing and replacing ordinary blueprints—thus creating a wide demand for personnel trained to make these drawings. Third of a series on graphical projection, this article details Bush Superposition three-point perspective.

PICTORIAL DRAWINGS and sketches employing isometric, oblique, and perspective projections have, generally, been found significantly superior to conventional orthographically-projected engineering drawings when shape-description is sought. Essential shape and basic component parts of an object are revealed at a glance through these pictorial presentations, and little or no training is required to read them. Hence, the growing importance of perspective projection.

Having detailed the introductory principles and one-point perspective in Part I of this series (page 118, Jan. AVIATION) and two-point perspective including inclined vanishing points and reductions and enlargements in Part II (page 150, Mar. AVIATION) we will now consider three-point perspective and the Bush Superposition Method. For details of Methods 1 and 2 and Principles 1 and 2, dealt with in the following explanations, see page 125, Part I, Jan. AVIATION.

To begin with, this three-point perspective is that obtained when none of the three principal axes of the object is parallel to, or in, the *PP*, as in Fig. 14. There, as the right view indicates, *PP* makes an angle of 45 deg. with the *GP* upon which the box rests, with the vertical edge *BF* the nearest to *PP*. As the auxiliary view over the right end view will show, the box has been rotated in a plane parallel to the *GP* through an angle of 30 deg. for generality.

The perspective obtained will be a bird's-eye view of the box, i.e., the view as seen by the eye at *SP*, with *CV* being somewhere near the center of the perspective so that most of the sight lines are within reasonable perpendicularity with *PP*. Vertical lines will no longer show their perspective projections vertical. Instead, they will converge, in the perspective view, to a *DVP* (down vanishing point). By Principle 2, the *DVP* of Fig. 14 is the point where a sight line, parallel to the vertical line-set, pierces *PP*. The two views of this piercing point give *DVP* in Fig. 14. The end view is at *W* where the line $(SP)^R P$ pierces *P*, and the front view is on the horizontal from *W* and directly under (SP^T).

As far as the actual perspective projection is concerned, the type first to be used here in the explanation of this advanced, yet highly important, problem of three-point perspective is original with the author and represents a simplification over previous methods in points of time required and the number of complete lines necessary. This is due largely to the fact, that the *PP*, in the top and end view, has been made an edge view. This, of course, requires a sloping *HP* and *GP*, since the angle between either of these two and the *PP* is, in this particular instance, 45 deg. If the *GP* and *HP* are kept horizontal and the *PP* made to slope at the required angle, a second type of projection obtains. The author's second type, although involving a sloping *PP*, as in the former, conventional methods, will differ after that by another original contribution of the author's in respect to the manner in which the piercing points, by the sight lines of *PP*, are obtained.

When the object has numerous lines in its various parallel line-sets, a combination of Methods 1 and 2 may be advisable, although it must be emphasized that the advantage of the combination over Method 1 is not great. For purposes of illustration, this combina-

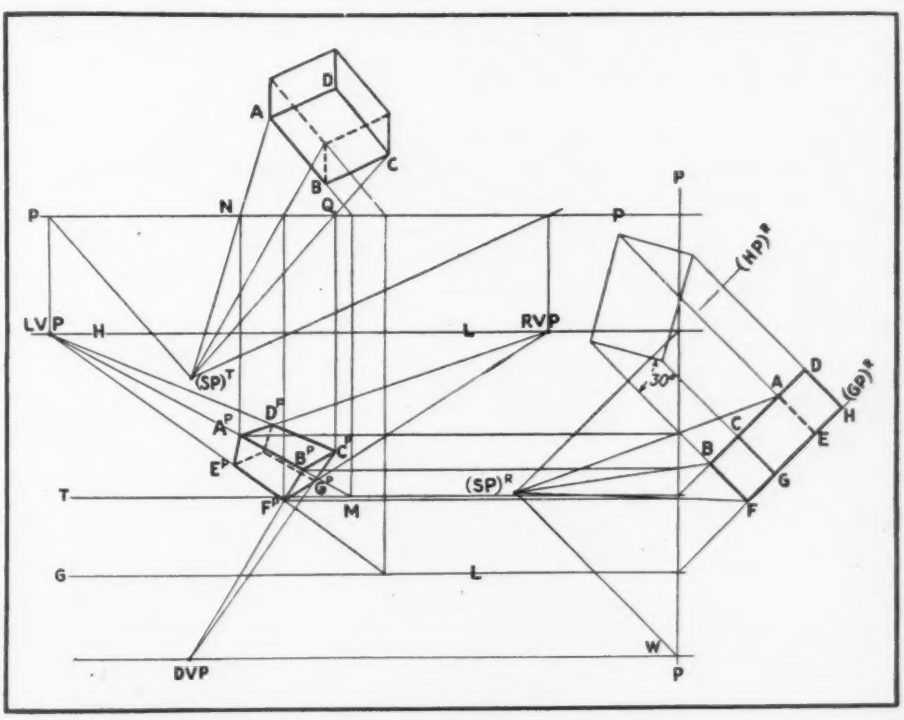
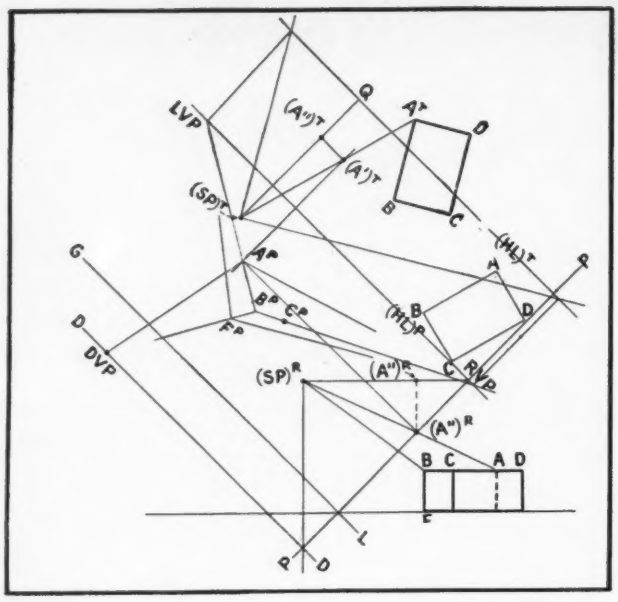
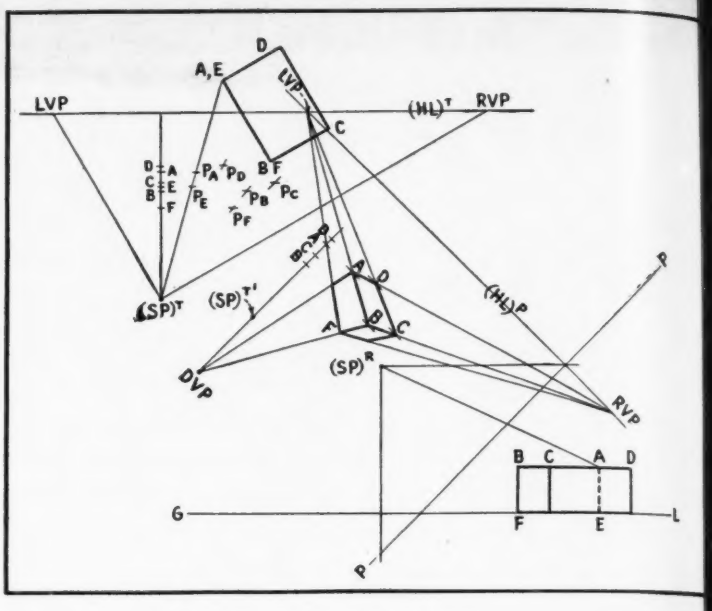


Fig. 14. Three-point perspective (front edge behind picture plane) by Methods 1 and 2 (both Type 1) bird's-eye view.

*A book, *Engineering Sketching*, is being prepared by Prof. Bush for early publication.





Figs. 15a (left) and 15b (right). Three-point perspective (front edge behind picture plane) now of Type 2 and working into the superposition method, bird's-eye view.

tion of Methods 1 and 2 will be used here.

Referring to Fig. 14, the location of *SP* in the top and end views is assumed and *PP* shows in all views as an edge, i.e., it is perpendicular to the plane of the paper. Obviously, *GP* and *HP*, which are parallel planes, will slope up and right in the end view and their intersections with *PP* will be the lines *GL* and *HL*, respectively. The intersection of the plane *T*, containing the top of the box, with *PP* gives the line *T*. This is the line in *PP* from which the horizontal lines in the top of the box, containing lines like *AB*, will be drawn in perspective to either the *LVP* or *RVP*, as for *M* (*LVP*). Perspective of corresponding lines in the bottom of the box will be drawn from *GL*. The determination of *LVP* and *RVP*, by the author's type of projection, is obvious and represents no new procedure as would be occasioned by use of previous conventional methods. Outlining the complete projection:

1. Locate *LVP*, *RVP*, and *DVP*, as shown.

2. Locate the perspective containing *AB*, i.e., *M(LVP)*, as shown.

3. Locate A^P on *M(LVP)* by using the vertical from *N*, which was found as the piercing point of *PP* by the sight line $(SP)^T A$. Check this location of A^P by using the end view and Method 1. Similarly, locate B^P.

4. Draw $A^P RVP$ and $B^P RVP$.

5. Find C^P on $B^P RVP$ by using a line from *Q*, which was found as the piercing point of *PP* by the sight line $(SP)^T C$.

6. D^P is where line $C^P(LVP)$ intersects the line $A^P(RVP)$. (Check this location with Method 1 or 2.)

7. Find F^P by Method 1. Check to see that it lies on $B^P(DVP)$.

8. G^P is the line of intersection of line $F^P(RVP)$ and $C^P(DVP)$.

9. Remaining points can now easily be located and the complete bird's-eye picture determined.

Notice in the above outline of procedure for Type 1 how the basic starting points for the various important phases of the perspective development, points like A^P and E^P, were really found by Method 1, and from these points how the *VP's* were checked, if not located.

Methods 1 and 2 are again combined in Fig. 15a, but the perspective projection is now of Type 2, since the *PP* is sloping at 45 deg. in the end view and *GP* and *HP* are the horizontal edge views. All other conditions, like the location of *SP*, are the same, as in Fig. 14. The outline of the procedure by which Fig. 15a is obtained, is as follows:

1. Locate the top views of the object, *SP*, *HL*, etc., using end view information when necessary.

2. Draw $(HL)^P$ at 45 deg. to *PP* from

Fig. 16. Three-point perspective (front edge behind picture plane) by Methods 1 and 2 (both Type 1) worm's-eye view.

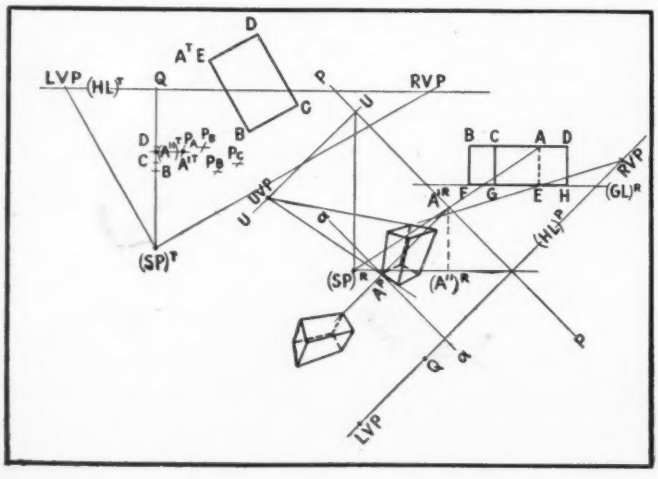
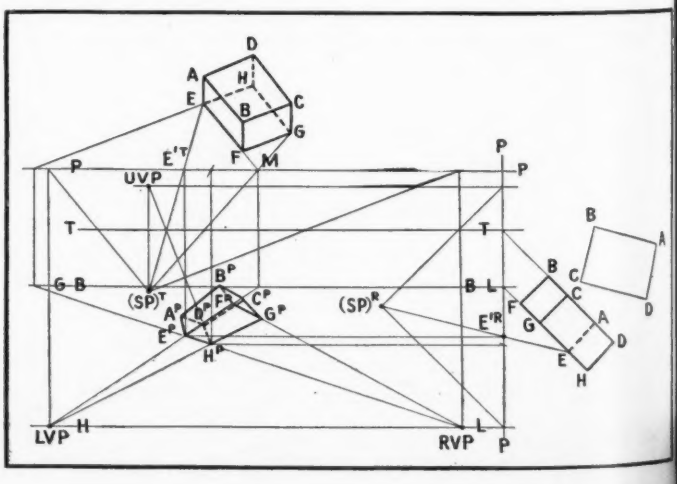


Fig. 17. Three-point perspective (front edge behind picture plane) by superposition method, worm's-eye view.



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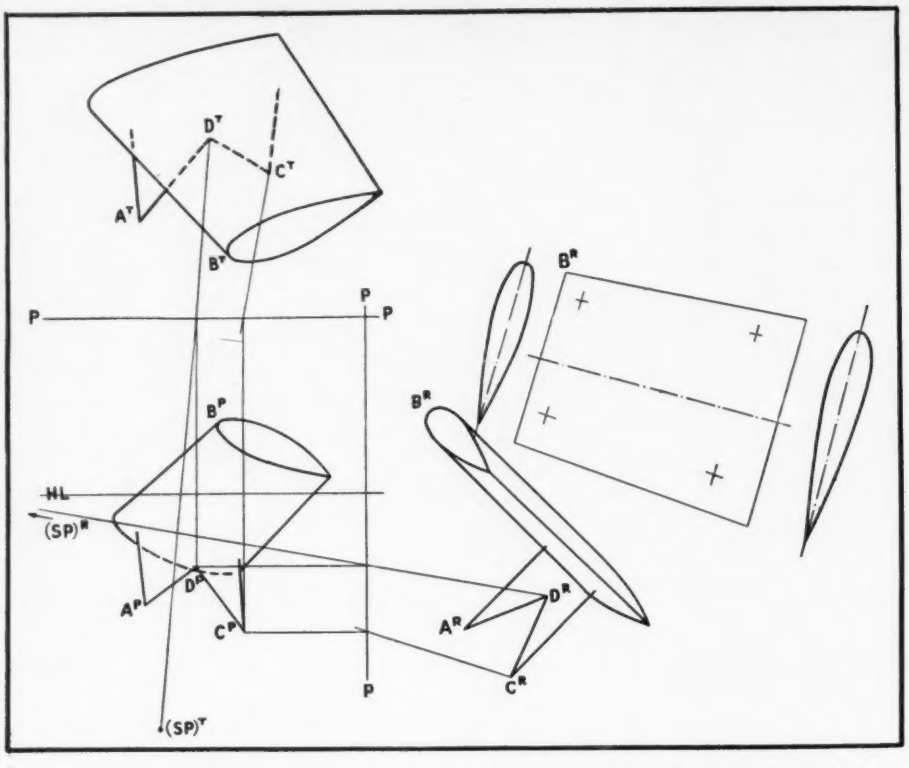


Fig. 18. Common perspective (worm's-eye view) of wing-tip mechanism of Consolidated PBY flying boat, by Method 1, Type 2.

the point where a horizontal through $(SP)^R$ pierces *PP*. Also locate and draw *DD* and *GL*.

3. Locate *LVP*, *RVP*, and *DVP*. For example, $(LVP)^T$ is on $(HL)^T$ at a point where a horizontal sight line from $(SP)^T$, parallel to *AB*, pierces *PP*. $(LVP)^P$ is directly below on $(HL)^P$. *RVP* is found through a line from $(SP)^T$ parallel to *CD*; *DVP* through a vertical line from *SP*, parallel to, say, *BF*.

4. Find A^P by Method 1, i.e., from the points in the top and end views where sight lines to *A* pierce *PP*. For example, in the end view, this is $(A')^R$, which is also on $(SP)^TA^T$ (top view). To find $(A')^T$, first lay off $(SP)^R$ $(A'')^R$ from $(SP)^T$ along $(SP)^TQ$ to obtain $(A'')^T$; second, a line parallel to $(HL)^T$ from $(A'')^T$ intersect $(SP)^TA^T$ at $(A')^T$; third, a line fro $(A')^T$ perpendicular to $(HL)^T$, inter sects a line from $(A')^R$, perpendicula to *PP*, at A^P.

5. By using step 4, other points, i necessary, can be located by Method 1 Method 2 may be combined with Meth od 1 to find the complete perspectiv shown.

In three-point perspective, Type 2 as illustrated by this Fig. 15a, the to view of the object is not in its norma position relative to the end view, as i normally is on an engineering draw ing using orthographic projection. T draw the perspective from such a nor mal engineering drawing, a piece o tracing paper or cloth may be laid over superposed, on the drawing and the to view of enough of the points, where the sight lines pierce *PP*, may be ob tained on the paper as in the above procedure, and as indicated in Fig. 15b. The tracing paper is then moved over the drawing so that its *(HL)* matches $(HL)^P$ located previously on the draw ing by laying out, on its end view, *PP*, $(SP)^R$, etc.

In this matching process, it is well to remember not to have the eventual perspective overlapping the end view, even in part. Note that distances like $(SP)^R(A'')^R$ may all be laid off at one time along a paper straight edge, then all laid off at one time along the line $(SP)^TQ$, as for *A*, *B*, *C*, and *D* in Fig. 15b, so that by horizontal projection the points like $(A')^T$ may be located all at one time. With the tracing paper in this new position, the procedure is the same as that outlined above for, and as indicated in, Fig. 15a.

With this procedure, orthographic engineering drawings may be used, without spoiling them, to obtain even the most general common perspective on a piece of tracing paper or tracing cloth. It affords the means of an artistic accomplishment to those with no "artistic ability". An important art factor now finds immediate and easy expression on a rational, exact, and technical basis. Those who previously could not "get a good likeness" will now be able to get the *exact* likeness, or enough basic points to simulate an exact likeness, by the above methods.

Comparison of the various methods and types discussed will indicate that a combination of Method 1 and 2, Type 2, and the superposition method of the author's, is in general the best method for obtaining a three-point perspective from conventional engineering drawings using orthographic projection. Although Type 1 involves a simple method for locating the *PP* piercing points, the top view of the object must be redrawn in an inclined position. Type 2 re-

(*Turn to page* 368)

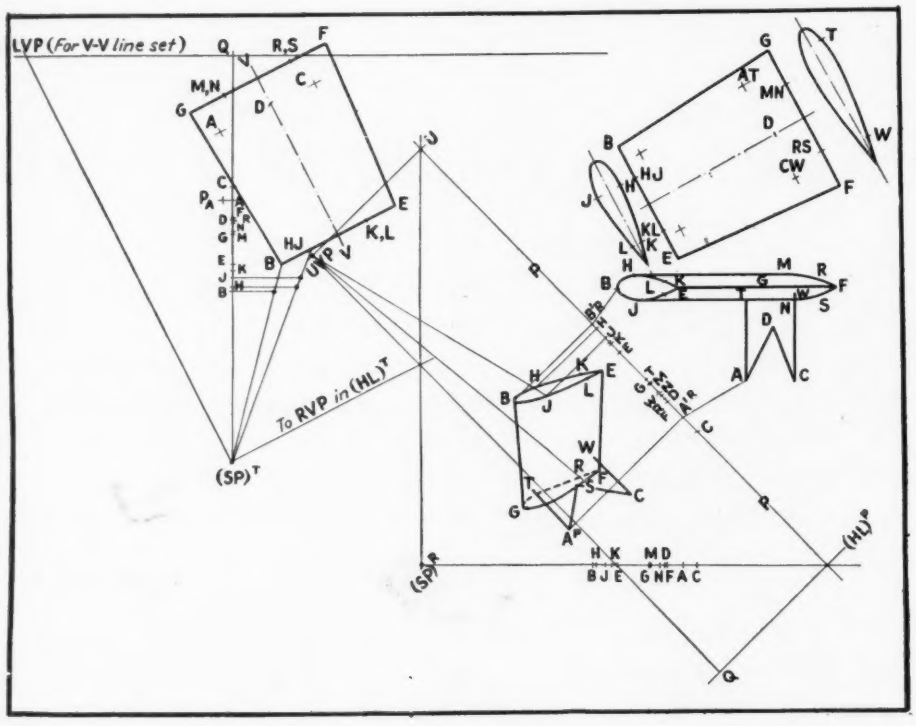
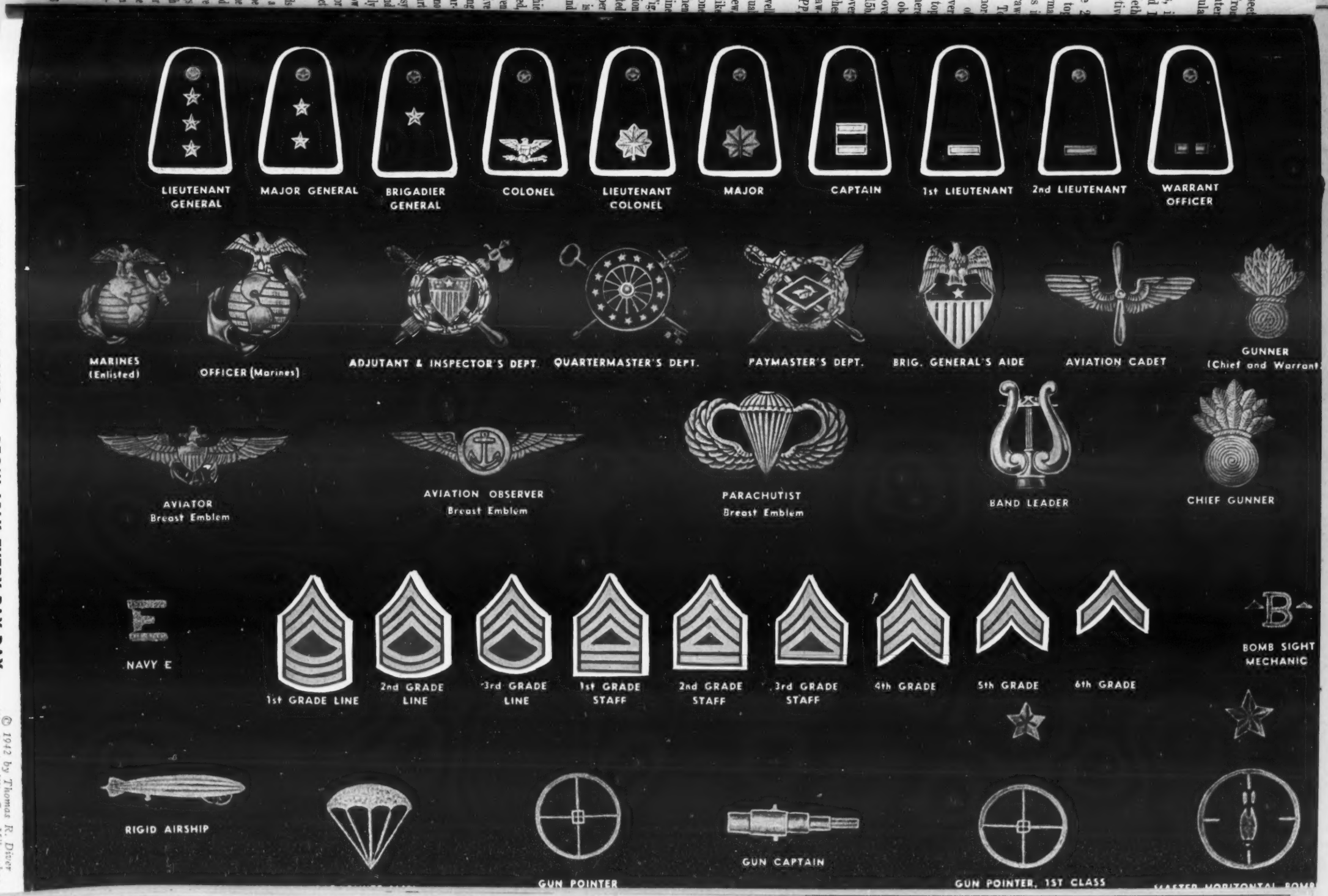


Fig. 19. Common perspective (worm's-eye view) of wing-tip mechanism of Consolidated PBY flying boat by Bush Superposition Method.



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Report of 38th SAE Meeting

Army member of SAE's aeronautical board, Col. Dave Lengle, chats with Past Pres. Arthur Nutt (left), vice-president and chief of engineering of Wright Aeronautical Corp., Mac Short of Vega, society's newly elected president, and his predecessor, Arthur W. Herrington, chairman of Marmon-Herrington and a director of Consolidated Aircraft.

Aviation men focus attention of their automotive allies on aircraft production, plane testing, and engine construction and operation. Mac Short, of Vega, starts his term as new president.

AS THE UNITED automobile and aviation industries continued to pour out planes and parts around the clock, further evidence of the strength and purpose of the alliance between men in these once-separated fields was provided by the 38th Annual Meeting of the Society of Automotive Engineers, held this year in Detroit.

As previously reported, the new president elected for the ensuing year is Mac Short, veteran of the last war's U. S. Army air service, former Massachusetts Institute of Technology instructor, organizer of the Vega Aircraft Corp. in 1937, and vice-president in charge of engineering of the Lockheed Vega combination which produced the *Hudson* bomber. He is the first plane builder ever to direct SAE.

Besides Mr. Short, other aviation men elected vice-presidents were John G. Lee (United Aircraft Corp.) to direct the aircraft division and S. K. Hoffman (Aviation Corp.) chairman of the aircraft engine section.

In his inaugural address the new president reminded his fellow members that the cooperation which has multiplied aircraft production should not be allowed to breed fears of post-war competition. "In the main I think the airplane companies will continue to produce planes, and the automobile companies will make cars," he said. "Each will stick to the work in which he was initially successful."

The 1,000 engineers who heard this

(*Turn to page* 394)

Col. T. B. Holliday presents his analysis of the comparative efficiency of electric and hydraulic systems.

In his home city, E. W. Austin (left), chairman of the SAE Detroit section, plays host to George T. Mason, president of Nash-Kelvinator Corp., and Carl Breer, executive engineer of Chrysler Corp.

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FACTORY MAINTENANCE

Proper Care of Compressed Air Plants

By ED C. POWERS
Compressed Air Institute

Compressors of all types have such an important part in all industry today that the WPB has allocated their purchase and production. Points covered here by a member of the Institute will help you get more out of your compressors.

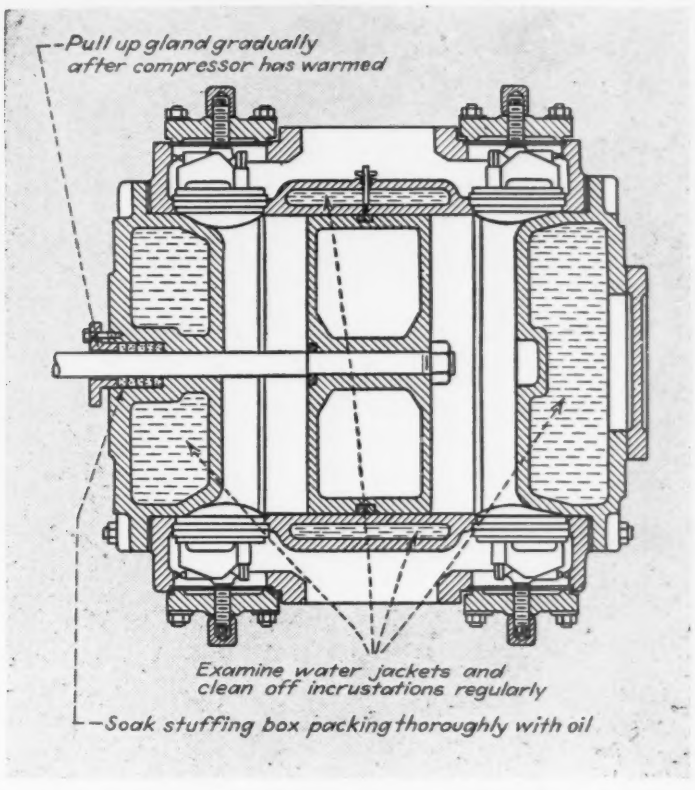

Pull up gland gradually after compressor has warmed
Examine water jackets and clean off incrustations regularly
Soak stuffing box packing thoroughly with oil

Fig. 1. Cross section of compressor cylinder and jackets.

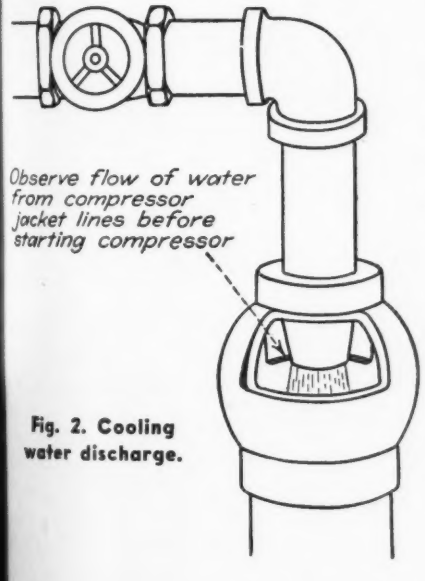


Fig. 2. Cooling water discharge.

IN THE CARE of the units of a compressed air system—compressor, air lines, intercooler, aftercooler, and receiver—certain fundamental precautions must be observed for efficient results and long life of the equipment.

When starting a new compressor, or one which has not been in use for a time, see that the crankcase is thoroughly cleaned of grit and foreign material and that it is filled to the proper level with oil. Cylinder lubricators should be clean and filled with oil suited to cylinder lubrication. Never use kerosene, gasoline, or other volatile petroleums, to clean valves and cylinders. They have caused explosions on subsequent operation of the compressor. Their use should be prohibited. In cleaning, be careful of lint deposits which may clog oil lines.

Above all, make certain that the intake line has been blown out and thoroughly cleaned of dirt, welding shot, scale, and grit. Many new compressors have had their valves and cylinder walls badly damaged by sucking in such material.

To make sure that all parts are clear before starting, the machine should be turned over a few times by hand. If the source of power is steam, drains on steam cylinder and steam pipe above throttle must be opened to clear the condensation. Power should be turned on gradually. With steam, the throttle should be opened slightly to heat cylinder. After this, it may be opened enough to turn over the compressor slowly. With single crank type, it will be necessary to bar it over beyond dead center.

Careful check of bearings and oil supply is required during first few hours. It is good practice to run in a new machine with compressor valves removed to allow breaking in under no load. After several hours operation they may be replaced, making sure the jam screws hold the valves securely seated. Pressure should be built up slowly.

Stuffing box packing needs thorough oil saturation. If soft packing is used,

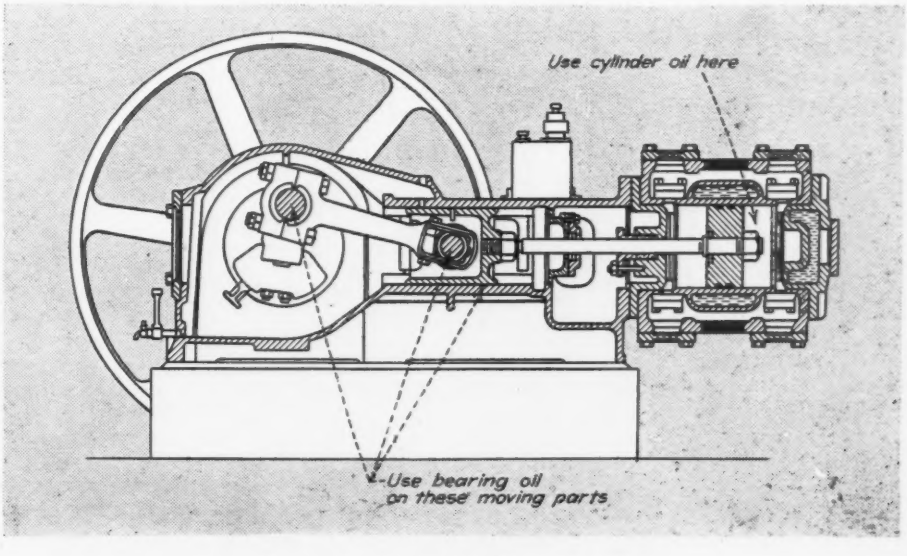


Fig. 3. Compressor and power units.

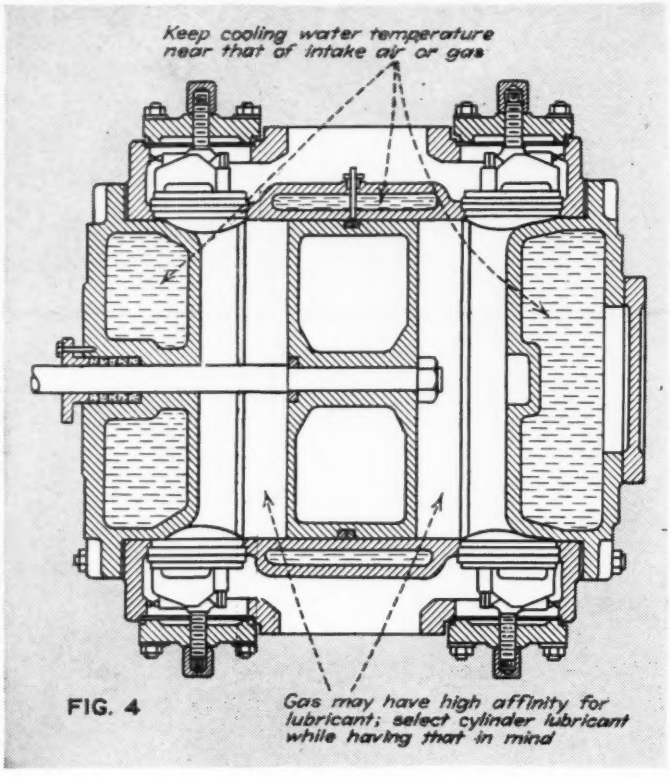

Keep cooling water temperature near that of intake air or gas
FIG. 4
Gas may have high affinity for lubricant; select cylinder lubricant while having that in mind

Fig. 4. Cross section of compressor cylinder.

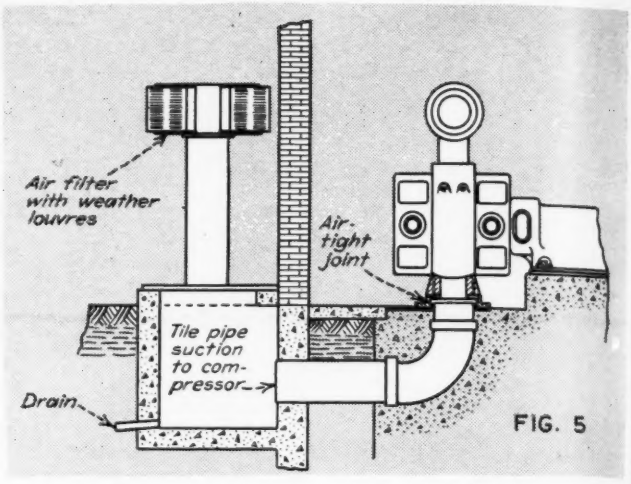


Fig. 5. Diagram of intake installation.

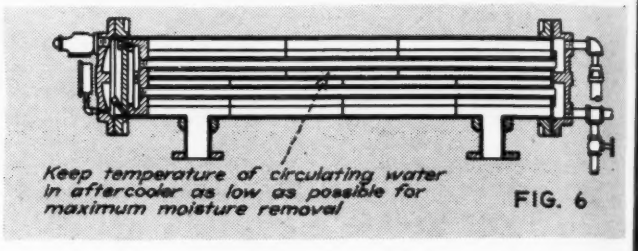


Fig. 6. Sectional view of aftercooler.

soaking in oil over night is advised. The packing nut should never be too tight on starting, for this may score the piston rod. After compressor has warmed up, the packing should be tightened just enough to prevent blow-by along the rod (see Fig. 1).

The cooling system should be checked for leaks before starting, and the jacket lines so connected that water flow is visible, either into an open funnel at the discharge (Fig. 2) or through pressure glasses in a closed system. Circulating water lines require drains at their lowest points, both for cold weather protection during shut-down and for cleaning and flushing.

It is essential to examine and clean water jackets at frequent intervals (Fig. 1). Their condition is a good index of the suitability of water used. Heavy deposits of hard scale form an insulation which reduces cooling efficiency. Jackets may be cleaned by a pressure jet for silt and soft deposits, or by dilute acid (10 percent hydrochloric or muriatic) for hard scale. This can be forced through jackets with a small circulating pump, or run through from a container placed above the cylinders. It is important to neutralize acid in the jackets with an alkali after cleaning to prevent damage.

In the operation of two stage compressors, disturbance of normal intercooler pressure is one of the first indications of trouble. If intercooler pressure rises, there is something wrong in the high pressure cylinder, such as leaking or broken intake valves or defective piston rings. If intercooler pressure falls below normal, trouble may be looked for in the low pressure cylinder. Such a defect may also be evidenced by overheating of either discharge or intake valves. If valve covers are unusually hot, it means leakage either in the valve or through a blown out gasket between valve and cylinder. Particular care should be taken to prevent loose valves, since very slight play can cause breakage of valve seat, dropping parts in the cylinder and causing serious damage.

On the subject of lubrication, first consult specifications of the manufacturer. As many as three types of oil may be required by a reciprocating compressor —one type for the compressor cylinders, another for the driving gear, a third

(*Turn to page* 389)

OIL FEED RATE TABLE

Cylinder Diameter	Piston Displacement per Cylinder cfm.	Swept Surface per Cylinder, Square Feet per Minute	Oil Feed per Cylinder Drops per Minute	*Pints per 10 Hr.
Up to 6"	Up to 65	Up to 500	2 d. in 3 m.	.05
6" to 8"	65 to 125	500 to 750	1	.075
8" to 10"	125 to 225	750 to 1,100	4 d. in 3 m.	.10
10" to 12"	225 to 350	1,100 to 1,500	1–2	.112
12" to 15"	350 to 600	1,500 to 2,000	2–3	.188
15" to 18"	600 to 1,000	2,000 to 2,600	3–4	.262
18" to 24"	1,000 to 1,800	2,600 to 3,600	4–5	.338
24" to 30"	1,800 to 3,000	3,600 to 4,800	5–6	.412
30" to 36"	3,000 to 4,500	4,800 to 6,000	6–8	.525
36" to 42"	4,500 to 6,500	6,000 to 7,500	8–10	.675
42" to 48"	6,500 to 9,000	7,500 to 9,000	10–12	.825

* Figures in last column are based upon 8,000 drops per pint at 75 deg. F.

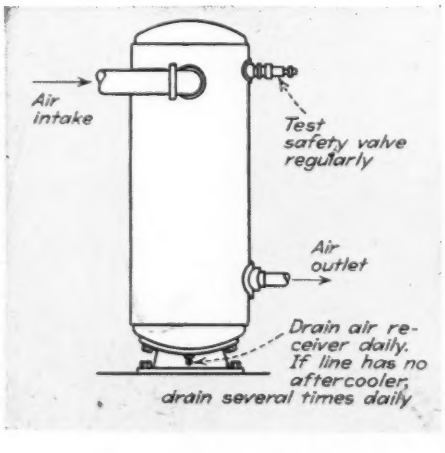

Air intake
Test safety valve regularly
Air outlet
Drain air receiver daily. If line has no aftercooler, drain several times daily

Fig. 7. Receiver fittings.

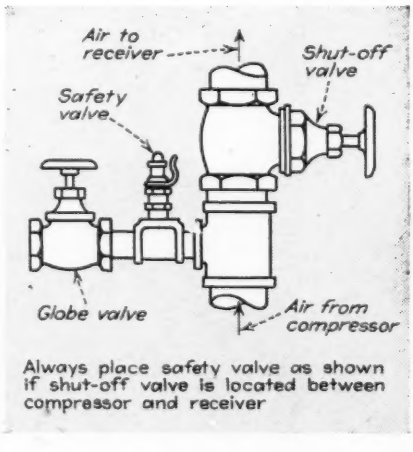
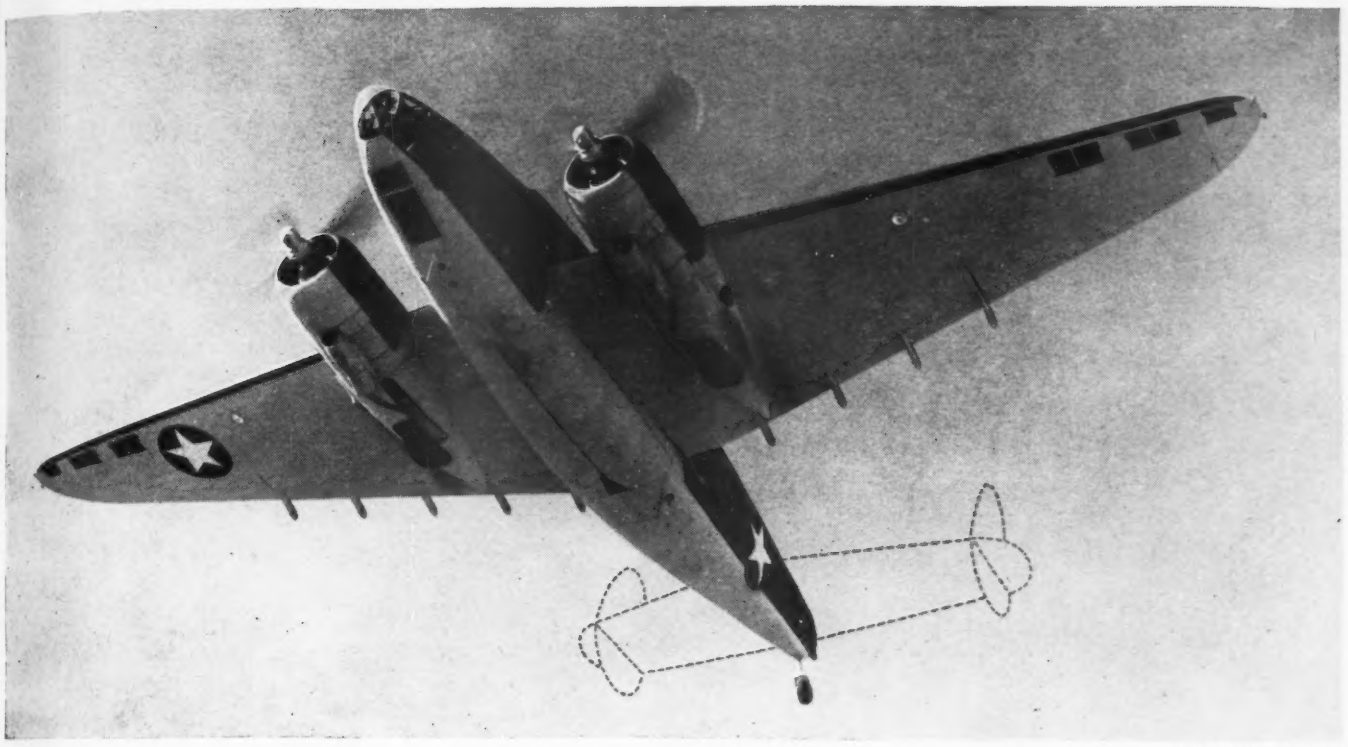

Air to receiver
Shut-off valve
Safety valve
Globe valve
Air from compressor
Always place safety valve as shown if shut-off valve is located between compressor and receiver

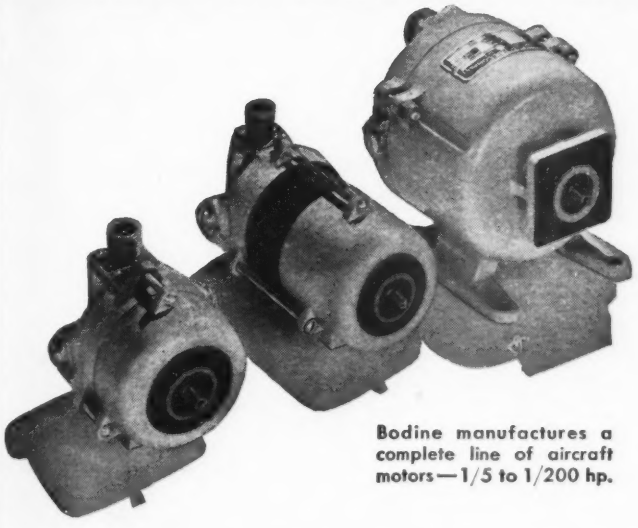
Fig. 8. Safety and shut-off valve.



Lockheed Aircraft Photo

This Bomber needs its tail surfaces—

its small electric motors are essential too!



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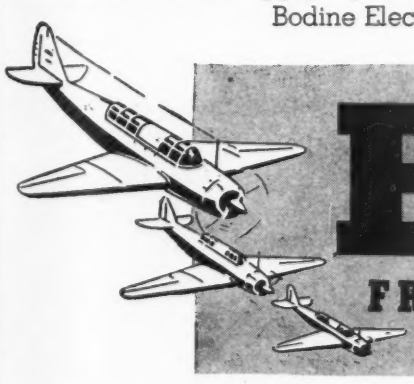

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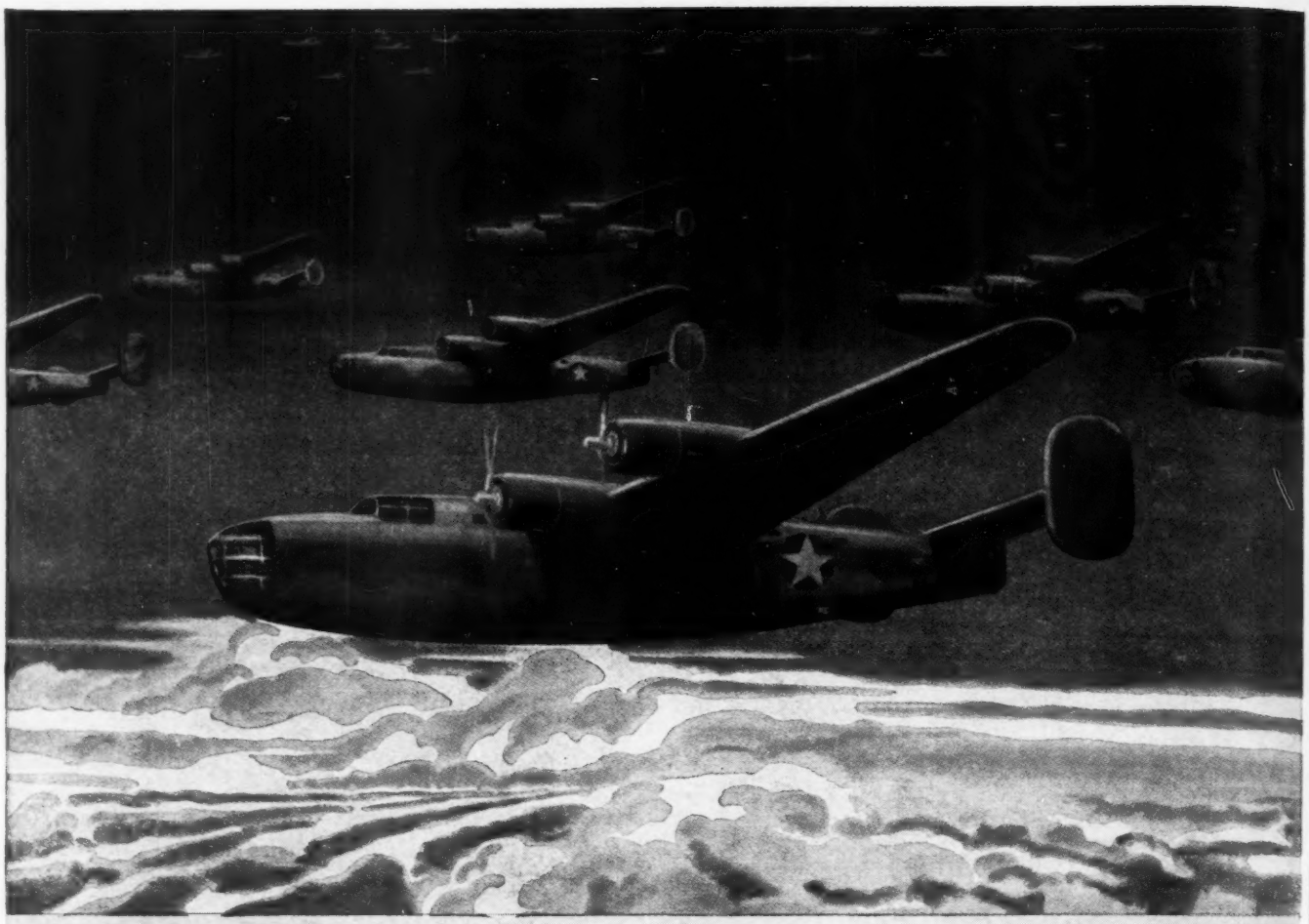

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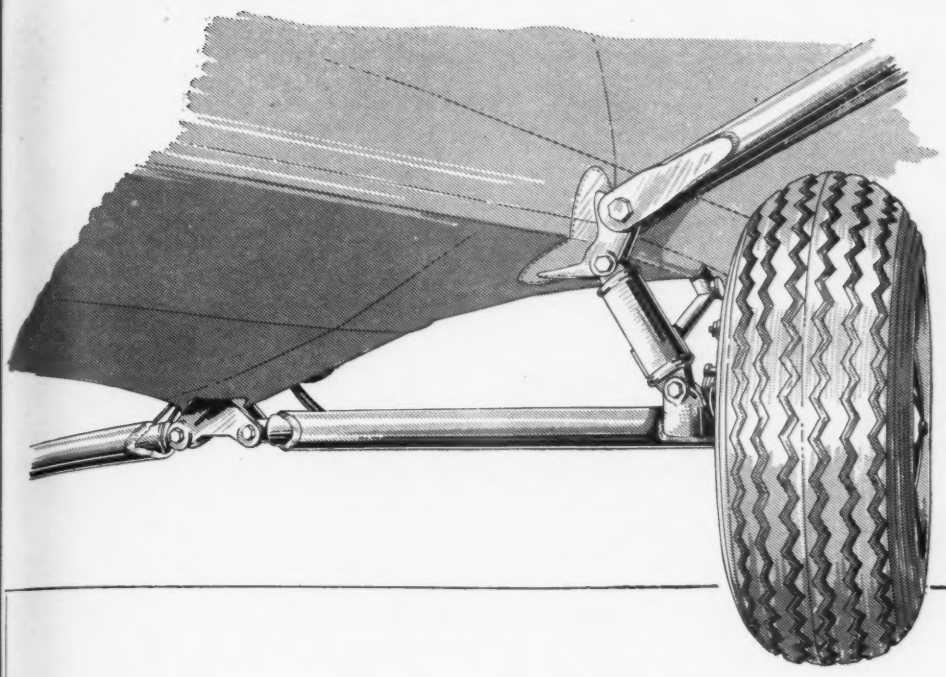
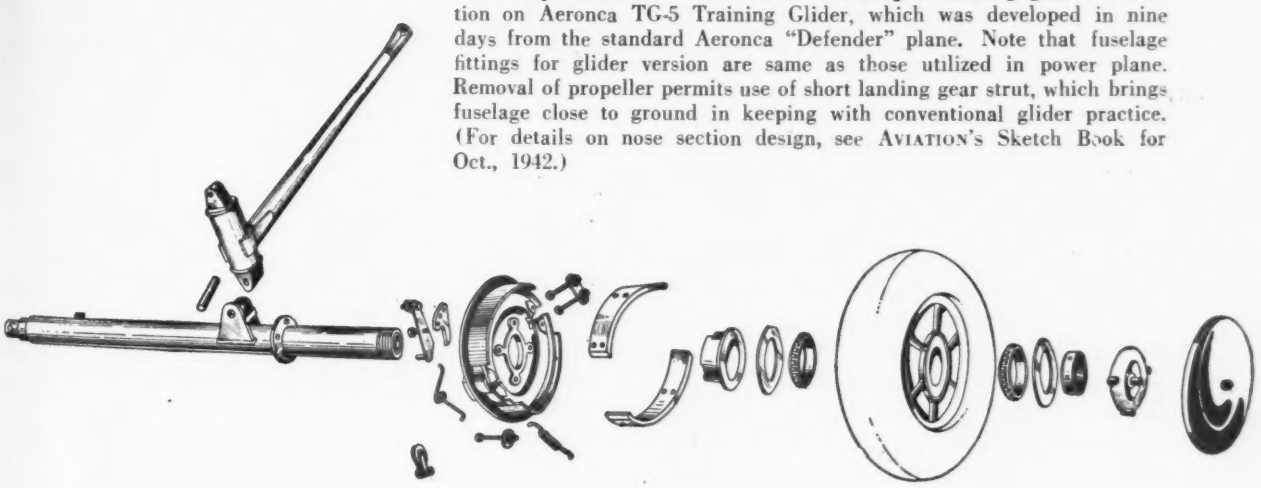
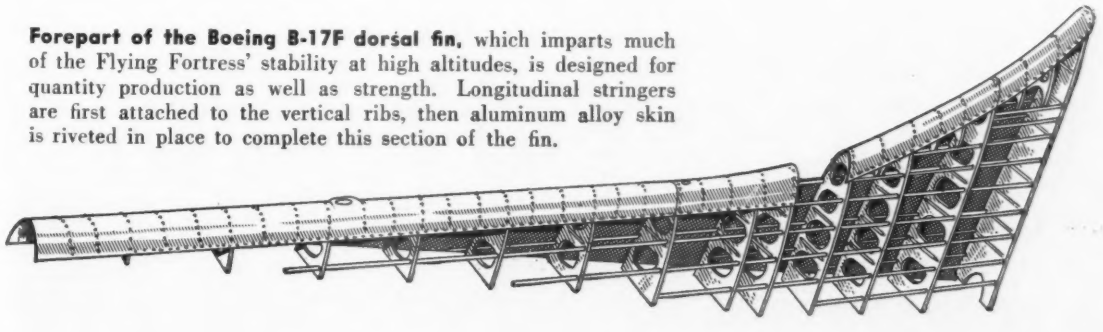


SKETCH BOOK OF DESIGN DETAIL

Assembly break-down and detail drawing of landing gear construction on Aeronca TG-5 Training Glider, which was developed in nine days from the standard Aeronca "Defender" plane. Note that fuselage fittings for glider version are same as those utilized in power plane. Removal of propeller permits use of short landing gear strut, which brings fuselage close to ground in keeping with conventional glider practice. (For details on nose section design, see AVIATION's Sketch Book for Oct., 1942.)



Forepart of the Boeing B-17F dorsal fin, which imparts much of the Flying Fortress' stability at high altitudes, is designed for quantity production as well as strength. Longitudinal stringers are first attached to the vertical ribs, then aluminum alloy skin is riveted in place to complete this section of the fin.



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In production for the Army Air Forces for observation-liaison work is Interstate Aircraft & Engineering Corp's. L-6 adaptation of craft developed for private flying. Increased use of transparent covering gives observer wide range of visibility essential for this type of work. Wing construction embodies spruce spars, metal ribs and fabric covering.

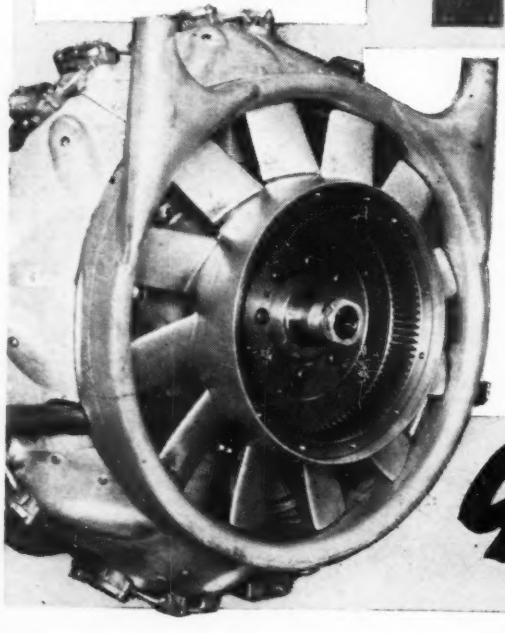
ESTABLISHED 1919

GUIBERSON

SAFER THAN SORRY — BETTER BE

AMERICA'S ONLY RADIAL AIR-COOLED DIESEL ENGINE

SAVE FUEL WITH GUIBERSON LIGHT WEIGHT DIESEL POWER



IN TANKS • IN PLANES • IN SHIPS

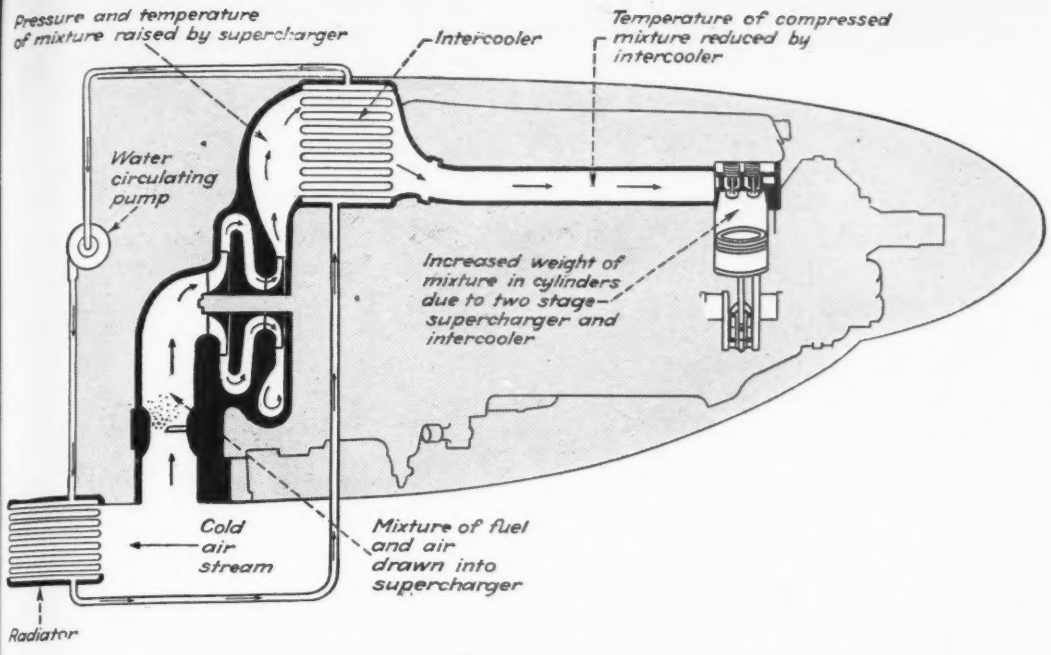
The Guiberson with its amazingly simplified and efficient injection system uses only 26.2% as much fuel per hour as a gasoline engine of equivalent power. And every pound of fuel, although it costs only a fraction as much as high octane gasoline, gives 50% more power!

In planes, in tanks, and in light ships the extra power and extra range per pound of fuel of the Guiberson can spell the difference between reaching an objective or failure to complete a mission. For low-cost, dependable operation without fire hazard or radio interference, it's the Guiberson—America's only radial air-cooled diesel engine.

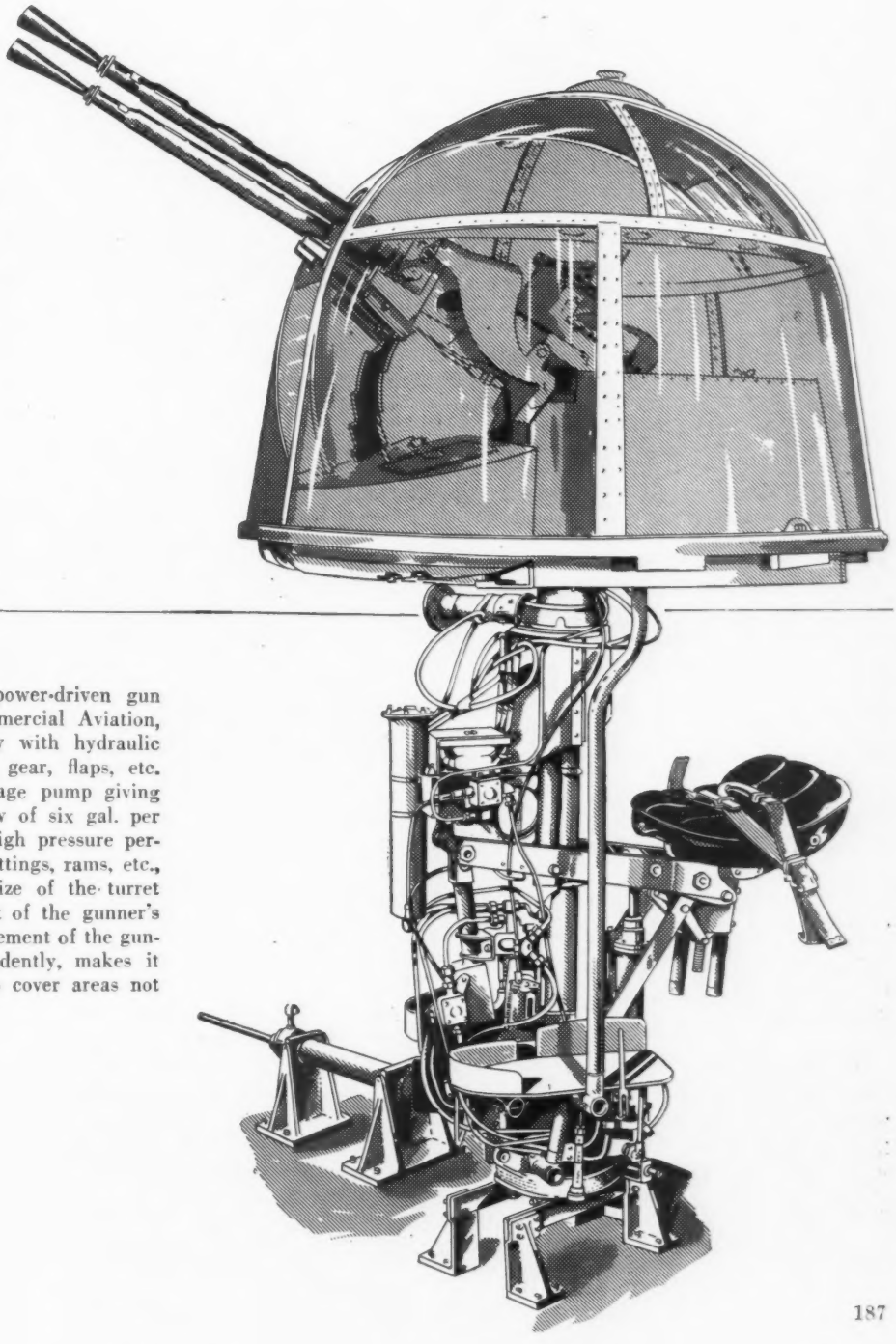
Guiberson U.S.A.

GUIBERSON DIESEL ENGINE COMPANY
DALLAS, TEXAS

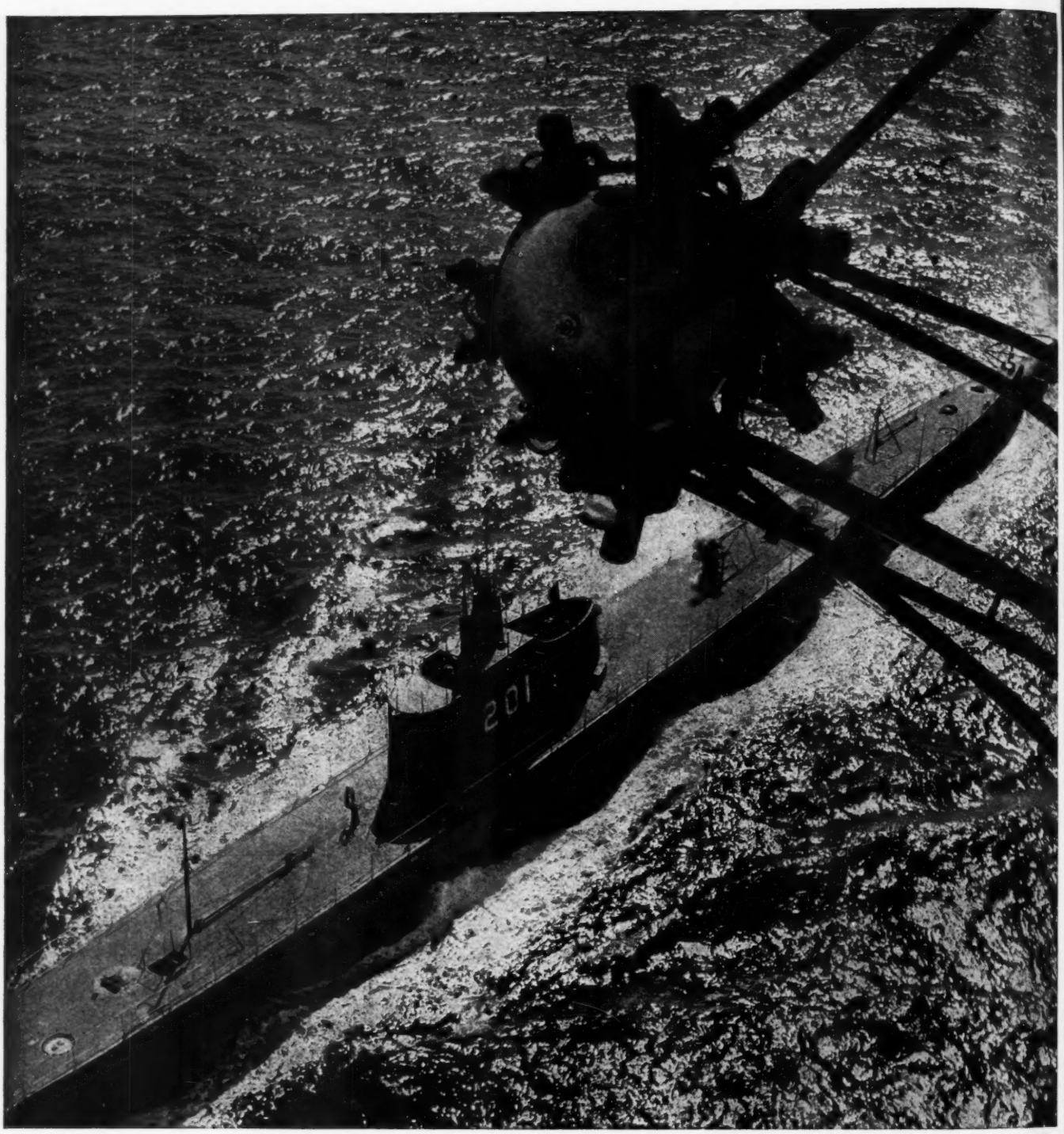
THE GUIBERSON CORPORATION
AIRCRAFT AND HEATER DIVISION


Pressure and temperature of mixture raised by supercharger
Intercooler
Temperature of compressed mixture reduced by intercooler
Water circulating pump
Increased weight of mixture in cylinders due to two stage-supercharger and intercooler
Cold air stream
Mixture of fuel and air drawn into supercharger
Radiator

Above, diagrammatic layout of two-stage supercharger as installed in Rolls-Royce Merlin 61 engine, power plant of the new *Spitfire* IX high altitude fighter, said to maintain desired pressure up to 40,000 ft., where charge is compressed to six times surrounding atmosphere pressure, giving twice the power of original Merlin III. This two-speed supercharger has two rotors driven on a common shaft, and utilizes liquid cooled intercooler mounted in induction system between second stage of supercharging and rear of cylinder blocks.



The Bristol hydraulically operated power-driven gun turret, re-drawn by courtesy of Commercial Aviation, uses a system developed concurrently with hydraulic systems used for retractable landing gear, flaps, etc. The "heart" of the unit is a three-stage pump giving pressures up to 1,500 psi, with a flow of six gal. per min. at normal engine speeds. This high pressure permits cutting down the sizes of pipes, fittings, rams, etc., thus reducing total weight. Over-all size of the turret is reduced by synchronizing movement of the gunner's seat with the guns. A "secondary" movement of the gun-column, which can be made independently, makes it possible to enlarge the field of fire to cover areas not reached by normal rotation.



OFFICIAL U. S. NAVY PHOTOGRAPH FROM HAROLD M. LAMBERT

Poison . . . and antidote

Each weapon in war has its match, or foil.

Sub and blimp. Tank and tank-buster. Minelayer and minesweeper. Aircraft and A. A. gun.

Yet they all have one thing in common. Being mobile mechanisms, they operate with revolving shafts and gears that turn on *anti-friction* bearings. Without such bearings there could be no ease of movement, no "fluid" flow of power, no *sustained* performance. Friction would freeze motion.

And since "nothing rolls like a ball," engineers use New Departure ball bearings for thousands of installations ranging from tiny precision instruments to the transmissions of mighty tanks—as well as for the machines that make them.

New Departure is making bearings by the millions. In fact New Departure has a major responsibility in the whole ball bearing war production program.

And we are looking forward to the day when these ball bearings will again be available for peacetime purposes in even higher quality because of the lessons of wartime production.

3158

New Departure
THE FORGED STEEL BEARING

Aircraft Steel Tubing

Standard Sizes and Purchasing Instructions

TUBE MILLS have made a thorough study, for quite a period of time, of the various tube sizes which they have been asked to make. As a result of this study, it was found that the most common sizes are limited to 205, including tubes up to and including 3" diameter. Users should make every attempt to order aircraft tubing according to the tables of standard sizes, attached.

TABLE OF STANDARD SIZES FOR AIRCRAFT TUBING

Wall Inches	Outside Diameter in Inches																						
	1/16	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8	7/16	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3
ALLOY SEAMLESS AIRCRAFT TUBING (not stainless)																							
.022	*	*	*	*																			
.028	*	*	*	*	*	*		*	*	*	*	*											
.035	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*				
.049	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
.058		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*			
.065		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.083				*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.095			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.120						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.125						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.156								*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.188								*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
.250									*		*	*	*		*		*	*	*	*	*	*	*
X4130 WELDED AIRCRAFT TUBING																							
.028					x	x	x	x	x	x													
.035				x	x	x	x	x	x	x	x	x	x	x	x	x							
.042				x	x	x	x		x	x					x								
.049				x	x	x	x	x	x	x	x	x	x	x	x	x							
.058						x	x	x	x	x	x	x	x	x	x	x							
.065						x	x	x	x	x	x	x	x	x	x	x							

Aircraft Tubing Purchasing Instructions

In an effort to facilitate the placing of orders for steel tubing (welded and seamless) used in connection with the manufacture of aircraft and to help eliminate delays due to lack of sufficient information, the following should be carefully studied and the applicable data made a part of every order:

(a) Size must be indicated by only two dimensions (O.D. or I.D. and wall or O.D. and I.D.) Standard sizes of aircraft tubing should be ordered whenever possible. See attached lists of tubing industry standardized sizes.

(b) Grade (steel analysis and temper).

(c) Specify random lengths wherever possible. Also state finished part length. This may enable the mill to ship tubes which might otherwise be rejected because of length variation.

(d) Furnish drawing of finished part when tubes are to be machined on O.D. or I.D. or both. If drawing is not available, state finished dimensions after machining. In specifying the rough tube size, eccentricity, decarburization, and the sequence of machining operations must be considered.

(e) When tubes are to be deformed (bent) or otherwise specially treated, furnish the mill with full information so that correct temper will be supplied.

(f) Stipulate government (A-N) or AMS specifications wherever possible, and do not make "commercial" references because they may be misleading. Where AN OR AMS specifications do not cover requirements adequately, tubing manufacturer's standards, as outlined in American Iron & Steel Institute's *Steel Products Manual*, Section 18, will apply.

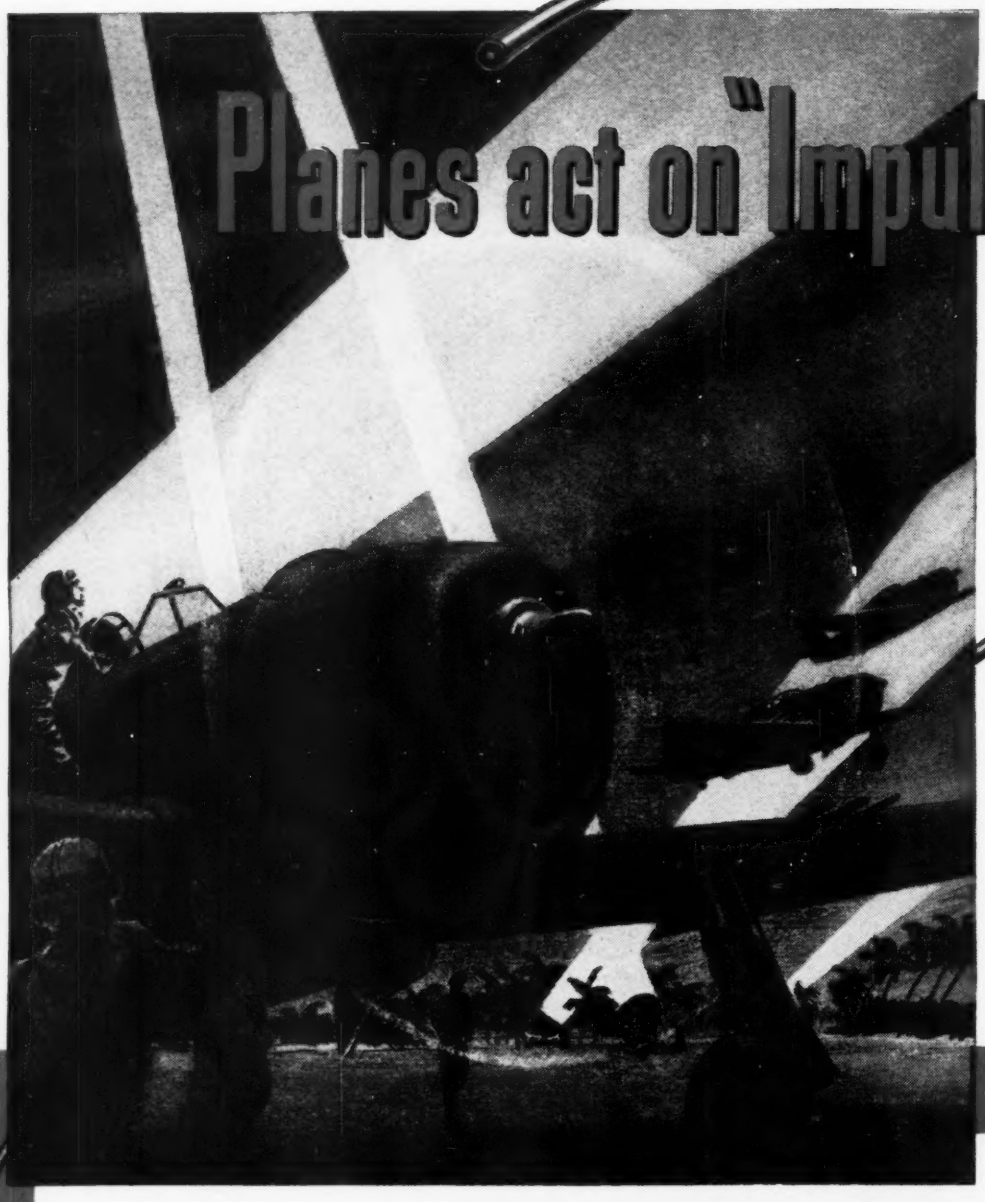
(g) Following data are to be indicated and grouped together on every purchase order.
- Preference rating
- Contract number
- Group classification (see general preference order M-21).
- Identifying S-U number (Scheduling Unit Form 18).
- Statement that delivery requested is not in anticipation of actual requirements.

(h) Indicate destination and routing of material.

(i) Indicate whether or not government inspection is required and at which point this inspection will take place.

(j) Specify number of invoices and test reports.

(k) On welded tubing, specify inside flash condition if this is not covered in the particular specification to which the material is ordered.



In the grim air battles America's fighting and bombing planes are waging on battlefronts the world over, life and death, victory or defeat depends on every plane's instant response to the will of its pilot. Yet these planes do act on impulse—electrical impulse.

That's why the complicated system of wires controlling ignition, power, lighting and instrument installations must be—and *has been*—precision-engineered.

Auto-Lite supplies its famous Steelductor Cable for the high tension ignition wires of many of our nation's "war birds." And Auto-Lite research has also developed a variety of low tension cables that meet every Army-Navy specification. In fact, they offer definite advantages in greatly improved resistance to abrasion.

Every type of wire and cable manufactured by Auto-Lite for modern aviation meets the rigid demands of this exacting industry. We have had numerous requests for Form No. 666, covering Steelductor Cable, and Form No. 838 on Low Tension Cable. Write for your copies today.

THE ELECTRIC AUTO-LITE COMPANY
PORT HURON, MICH. • *Wire Division* • SARNIA, ONTARIO

AUTO-LITE AIRCRAFT WIRE and CABLE

IN ITS 26 GREAT MANUFACTURING DIVISIONS, AUTO-LITE IS PRODUCING A LONG LIST OF ITEMS FOR AMERICA'S ARMED FORCES ON LAND, SEA AND IN THE AIR

Aircraft Steel Tubing

Specifications and Definitions

Specification No.	Analysis	Explanation of Specifications
		Seamless aircraft tubing
AN-WW-T-846	(1025)	Covers 1025 steel used to limited extent in aircraft.
AMS-5075	(1025)	Generally similar to AN-WW-T-846, except closer carbon range (.21–.29).
AN-WW-T-850a	(X-4130)	This specification is for Army-Navy and general use and is the one principally employed for the purchase of seamless X-4130 round, square, rectangular, oval, and streamline aircraft tubing. It provides for furnishing tubes in condition A (annealed); in condition N (normalized or cold drawn and stress relieved), or heat-treated to various quenched and tempered mechanical properties. Unless otherwise ordered, the tubing is supplied in condition N. Special operations such as bending or otherwise deforming, etc., are sometimes performed on tubes ordered to this specification. Such tubing is usually furnished in condition A (annealed) and the purchaser should furnish full information on his order when he intends to make special applications of such tubing.
AMS-6360A	(X4130)	Similar to AN-WW-T-850a but differs in grain size and specification details. It has been employed principally by motor manufacturers, but the quantity of tubing ordered to this specification has been small when compared to that ordered to AN-WW-T-850a. Indicates magnaflux testing.
AMS-6361, 6362, 6363	(X-4130)	The above are similar to 6360A but provide for 125,000, 150,000 or 180,000 psi. minimum tensile.
AN-WW-T-852a	(X-4135)	Similar to AN-WW-T-850a, except requires X-4135 steel, and was written primarily to cover relatively heavy wall tubing.
AMS-6365	(X-4135)	Similar to AN-WW-T-852a. Same comments apply as made regarding 6360A.
AMS-6366, 6367, 6368, 6369	(X-4135)	Same as #6365, except provision is made for 125,000, 150,000, 180,000, or 200,000 psi. minimum tensile.
M-491	(X-4340)	Navy specification covering X4340 steel for high strength structural parts.
AMS-5050	(1010)	A low carbon analysis of special manufacture generally used for motor oil lines, hydraulic lines, intake tube, etc.
		Seamless Stainless Aircraft Tubing
AN-WW-T-855 (Amendment 1)	(18–8)	This specification is for 18–8 straight analysis for general corrosion resistance where no welding is encountered except spot welding. Material is supplied annealed or quater-hard.
AN-WW-T-858 (Amendment 1)	(18–8) (stabilized)	Provides for a columbium or titanium stabilized 18–8 used for corrosion resistance where welding is likely to be used Supplied annealed only.
AMS-5570B	(18–8) (stabilized)	Similar to AN-WW-T-858.
		Welded Aircraft Tubing (Carbon and Alloy — except Stainless)
AN-T-3	(X-4130)	This specification is for Army-Navy and general use and is the one principally employed for the purchase of welded X4130 round, square, rectangular, oval, and streamlined aircraft tubing. It provides for furnishing tubes annealed, in condition N (normalized or cold drawn and stress relieved), or heat treated to various quenched and tempered mechanical properties. Unless otherwise ordered, the tubing is supplied in condition N. Special operations such as bending or otherwise deforming, etc., are sometimes performed on tubes ordered to this specification. Such tubing is usually furnished in condition A (annealed) and the purchaser should furnish full information on his order when he intends to make special applications of such tubing.
AN-T-4	(1025)	1025 round, rectangular, and square aircraft tubing.
AMS-5077	(1025)	1025 round, rectangular, and square aircraft tubing.
AMS-6510	(X-4130)	X-4130 round aircraft tubing.
USA-10245	(1025)	1025 tubing for gliders only. Tubes are furnished as welded or cold drawn and annealed, as ordered.
AN-WW-T-833	(X-4130)	75 percent nickel, 14 percent chromium, 9 percent iron alloy for aircraft use.
Dept. of Commerce P+P 10–2	(X-4130) and 1025)	Covers 1025 and X4130 as ordered. However, these specifications have been superseded by AN-T-3, AN-T-4.
AMS-5053	(1010)	Low carbon analysis of special manufacture generally used for motor oil lines, hydraulic lines, intake tubes, etc.
		Welded Stainless
AN-WW-T-861	(18–8) (stab'l'z'd)	18 chromium 8 nickel corrosion and heat resisting steel-stabilized with columbium or titanium.
AMS-5575A	(18–8) (stabilized)	Similar to AN-WW-T-861.
		Seamless Aircraft Mechanical Specifications
AMS-6371	(X-4130)	Cold drawn or hot rolled tubes
AMS-6381	(X 4140)	Cold drawn or hot rolled tubes
AMS-6413	(X-4335)	Cold drawn or hot rolled tubes

Notes:

1. Definitions
   A. Aircraft Tubing:
   This term designates a tube with size, analysis, mechanical properties, and surface finish suitable for use in fuselage or airframe construction. Seamless tubes for this purpose are always furnished cold drawn, and electric welded tubing for this application is made only from cold rolled strip. Special processes and quality selection have been established for the manufacture of aircraft tubing. It is supplied either annealed, normalized, or specially heat-treated and is commonly used in the condition as supplied by the manufacturer. However, in some cases, such tubes may be deformed, partially machined, ground, or heat-treated by the user.
   Aircraft tubing is usually ordered to government specifications (AN) or specifications promulgated by generally recognized agencies. (See Note 2, below.)
   B. Aircraft Mechanical Tubing:
   This term designates a cold drawn or hot rolled tube of analysis and internal steel qualities suitable for use in the aircraft industry in manufacturing axles, shock absorbers, landing gear struts, motor parts, or other similar applications. Magnaflux aircraft quality steel is recommended for the manufacture of these parts by the tube mill. However, both magnaflux aircraft quality and commercial steel grades are being widely used.
   Such tubes will have a relatively wide tolerance range, will be furnished with commercial surfaces. And special processing or selection is not required because the outside surface or the inside surface or both surfaces are completely machined by the user. Regular commercial standards of processing in effect for ordinary mechanical usages are employed by the tube mill. Where AMS do not adequately cover the requirements, standard dimensional tolerances will be found in the American Iron & Steel Institute's *Steel Products Manual*, Section 18.
2. All specifications prefixed by AMS apply to aeronautical material specifications published by the Society of Automotive Engineers.
3. Other grades of steel may be ordered to the above specifications but mechanical properties will vary with analysis.

Review of Patents

By A. HARRY CROWELL,
Registered Patent Lawyer

FOLLOWING are digests of some of the more significant recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish readers information, without charge or obligation, on approximate cost and procedure in applying for patents and trademark registrations. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York. Printed copies of any of the patents listed below are obtainable at 10¢ each directly from U. S. Patent Office, Washington.

Ground Speed Indicator. Gyroscopic instrument which functions independently of any movements on part of medium being traversed by instrument's carrier, to give at all times an indication of speed of instrument's carrier relative to a fixed or constantly moving object.—2,303,799, T. O. Summers, Jr.

Variable Pitch Propeller. In this form of construction, at take-off throttle is opened wide at start of the run, and blades, actuated by increased thrust, move against pressure of a compression spring. At same time, pilot may force hydraulic fluid into chamber provided in forward end of hub. This fluid moves piston and rack bars to left and additionally rotates blades to a minimum pitch angle resulting in an increased engine rpm. Pilot may in a similar manner obtain a greater rate of climb. Thereafter, fluid may be exhausted.—2,304,153, P. Di Cesare, assignor to Di Cesare Offset Propeller Corp

Hand Reel for Antennas. Improved manual reel for wire antennas, particularly for aircraft. Brake is arranged to decelerate reel from unwinding conditions to permit engagement of ratchet without danger of stripping. Stationary or rest position for reel is with ratchet and brake both engaged, assuring positive stop for antenna in any degree of extension.—2,304,184, W. P. Lear, assignor to Lear Avia, Inc.

Control Mechanism for Combination Flap and Aileron for Airplanes. An arrangement for combining the two movements involved when, for instance, in landing, pilot would want to increase lift of wings while plane speed is decreased, and when in making turns pilot would want to use differential mechanism in order to operate one aileron more than other.—2,304,487, J. B. Stinson, assignor to Stinson School of Aviation, Inc.

System of Ice Removal. An anti-icing system applicable to large or bulbous leading portions of aircraft, providing means for breaking an ice formation into unsupported segments which may be blown away by slipstream of aircraft. Method utilizes heat and certain special structural members to divide an ice surface into such unsupported segments.—2,304,686, D. Gregg, assignor to Bendix Aviation Corp.

Fuel-and-Air Control for Internal Combustion Engines. This invention, of particular application to aircraft engines, is designed to maintain proper ratio between mass of fuel and mass of air admitted to cylinders of engine despite variations in density of air in induction system of engine. It includes certain temperature and pressure devices with an operative connection between them.—2,305,070, L. F. G. Butler and R. K. Crowe, assignors to Bristol Aeroplane Co.

Bearing for Propeller Shafts. Sliding tube arrangement is used to support propeller shaft so that it can be swung in block of driving unit and flexibly supported in hull body or similar construction part. It is for use particularly where cylinders are mounted at an angle to each other.—2,305,454, F. Nallinger and A. Friedrich, vested in Alien Property Custodian.

Aircraft Vibration Flight Testing for determining flutter or other vibratory characteristics is made possible by use of apparatus covered by this patent. It is stated that plane may be tested and its flutter characteristics determined without actually producing dangerous flutter. Various electrical measuring apparatus is included.—2,305,268, E. E. Minor and S. A. Kilpatrick, assignors to Glenn L. Martin Co.

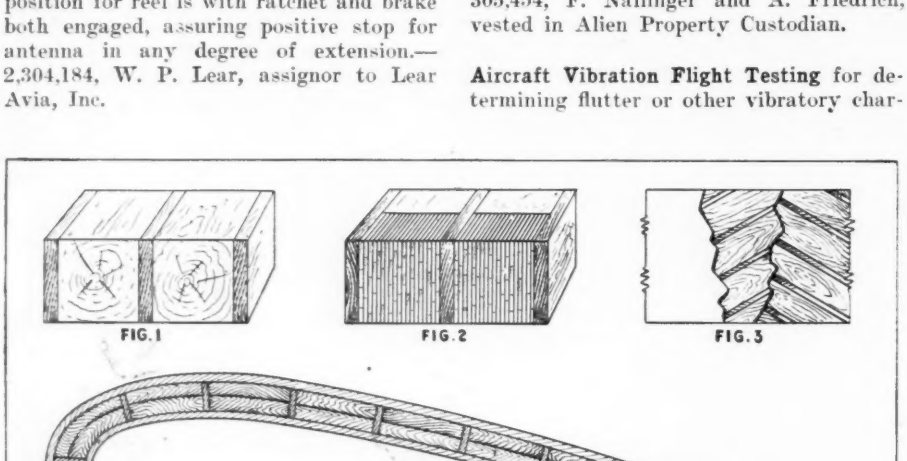
Rotary Wing Aircraft. This relates to type of craft in which sustaining rotor is normally power driven. Invention contemplates employment of means responsive to torque being transmitted to rotor blades to stop or greatly reduce power of power unit, thereby preventing re-application of normal driving torque. For example, power unit may be stopped by short-circuiting low tension winding of magneto or by closing throttle.—2,305,389, C. O. Pullin, assignor to Autogiro Co. of America.

Apparatus for Landing Aircraft includes an automatic radio control signal receiver for use with overlapping radio beams to enable blind landings. Receiver differentially amplifies signals of radio beams, so that desired artificial guide path is obtained. Ultra high frequency directive radio beams of 10^8 cycles per second are employed in apparatus.—2,307,023, W. T. Cooke and A. S. Maeder, assignors to Sperry Gyroscope Co.

Propeller Mechanism covered here has blades which can be adjusted from a negative pitch to feathered position. Mass of operating parts and forces encountered in use are distributed around periphery of blade to avoid excessive localized loads and unbalanced centrifugal forces.—2,307,101. W. J. Blanchard and C. S. J. MacNeil, assignors to The Winters National Bank and Trust Co., as trustee. Another patent (2,307,102) granted to same inventors and assigned to same bank, covers a regulator for an **hydraulic adjustable propeller.** Here, fluid system is entirely contained within mechanism which rotates with propeller, requiring no fluid pressure connection to engine or other stationary part. A member rotating with blades under substantial centrifugal force directly controls application of hydraulic pressure to secure accurate setting of the blades and correct regulation of engine speeds.

Launching Apparatus for Rocket Craft. Power is supplied by rocket blast itself. Launching mechanism separates from rocket and is left behind as reasonable speed is attained. Thus rocket may be set off quickly and undesirable effects of slow acceleration are avoided. Cradle for upward movement is mounted in a fixed frame and supports rocket craft.—2,307,125, R. H. Goddard.

Left: New type of plywood construction is covered in patent granted Heinrich Sukohl. Strips of pine, ash, or other high tensile wood with grain running longitudinally, are glued to a filling of balsa (Fig. 1) or straw (Fig. 2) then diagonally superposed (Fig. 3) into a wing section (Fig. 4).—2,305,817, vested in Alien Property Custodian.



(*Turn to page* 350)

Airplanes

make "duds" of cardboard heroes

Every prophecy about the end of Hitler begins with a prediction on the fall of Mussolini. Italy's hollow shell may be the doorway to Europe. American planes, poised on the lip of Africa, look like the key to that doorway. One Koppers division has been getting ready for that fateful day for years

— *building up the nation's greatest output of aircraft piston rings,*

— *teaching other companies the delicate art of making aircraft rings,*

— *helping a great sewing machine builder become a ring maker.*

Koppers American Hammered Piston Rings flew over Tokio with Jimmy Doolittle. They powered the plane that rescued Eddie Rickenbacker, strapped to the wings; they took the pounding in PT boats that carried MacArthur out of Bataan. Other Koppers divisions make ingredients for plywood planes and plastics, tars for airport runways, electrode pitch for aluminum, paints for planes and other products.

Koppers Company, Pittsburgh, Pa.

For Victory — Buy War Bonds and Stamps

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

40 miles by taxi across the Pacific

One of this war's most dramatic stories started when a take-off accident damaged the octant of this Flying Fortress. Hours later, off course, hopelessly lost and gas exhausted, its pilot landed it and the crew of seven on the open sea.

Packed into three little rubber "doughnut" life rafts, they floated for 3 weeks catching rain for water, and a fish or two for food, battling sharks, storms, hunger and thirst with unbelievable fortitude. One raft made land. A PT boat picked up the second.

A Kingfisher Navy observation plane spotted the third—3 men aboard. With room for only one in the cockpit, the others were lashed to the wings. The Pratt and Whitney Engines (equipped with American Hammered Piston Rings) taxied the overloaded plane across many miles of the Pacific to safety.

Workers in the foundry, the shop, the inspection department, all know that someone's life may depend upon each ring they make . . . which helps explain why every ring delivers that all-important last ounce of effort in time of need. Koppers Company, American Hammered Piston Ring Division, Baltimore, Md.

American Hammered Piston Rings

KOPPERS

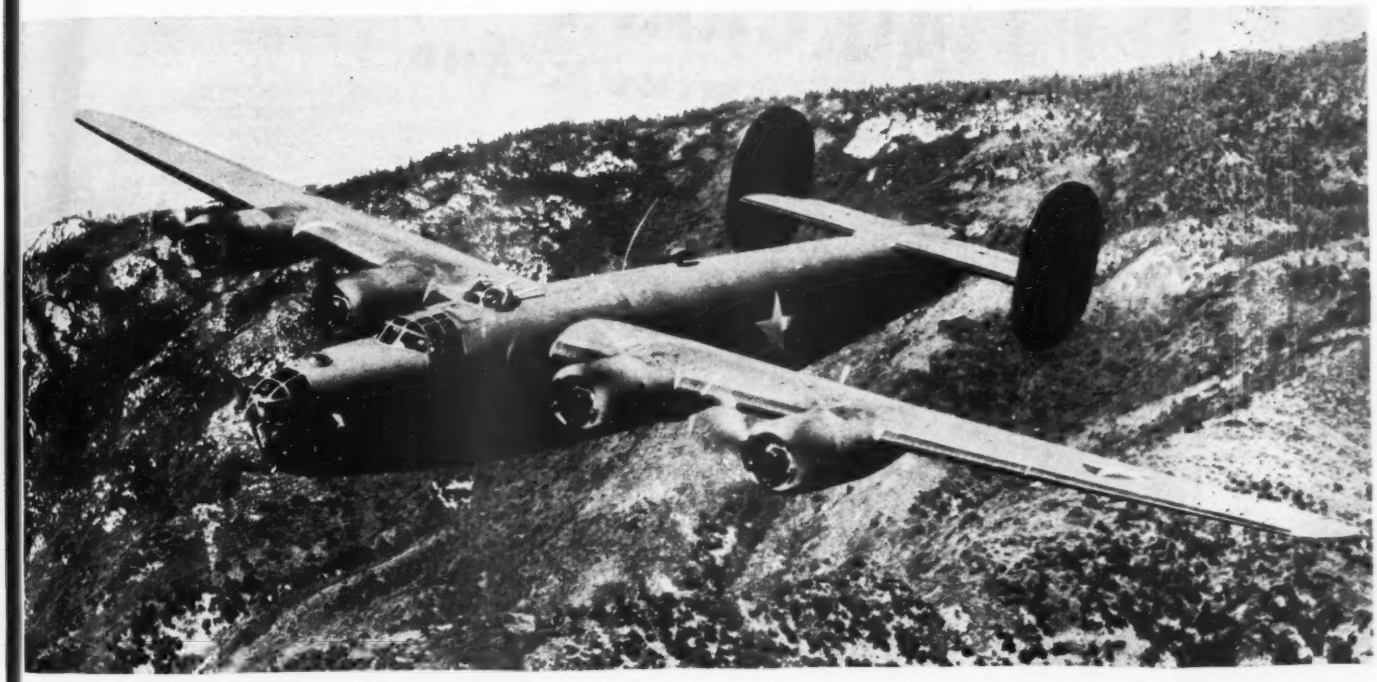
THE INDUSTRY THAT SERVES ALL INDUSTRY

Consolidated Subcontract System Coordinates Schedules

SUBCONTRACTORS SECTION

By HOWARD G. GOLEM
Supervisor of Subcontracting, Consolidated Aircraft Corp.

New approach to work dispersal combats ever-present problems of manpower and material. Growth and possibilities of company-owned "feeder shop" operation explained.



Famed B-24 *Liberator* which, with sister Consolidated planes C-87 *Liberator Express*, PBY-5 *Catalina*, and PB2Y *Coronado*, will soon be 40 percent subcontracted. Components "farmed out" include horizontal and vertical stabilizers, rudders, elevators, gun turrets, complete outer wing panels, wing tips, ailerons, flaps, leading edges, bomb doors, fuselage side panels, pilots' enclosures, ladders, seats, bunks, tables, galley equipment, and plastic plywood parts.

Because of the ever increasing demand for aircraft by our armed forces, the vast problems of subcontracting are literally just beginning to arise. Most larger aircraft companies are exhausting the supply of manpower in the immediate vicinity of their plants and are utilizing all available plant space for present mass production. The only answers to this are subcontracting and the use of feeder plants located in outlying districts, operated by the company. The feeder plant system is just beginning, and its full possibilities cannot at this time be evaluated. Steps which Consolidated has taken along this line will be discussed later in this article.

In view of the present expansion, the main problem is to displace manpower, material, machinery, and tools from the prime contractor's plant. Elimination of one department means room for expansion of another within the plant.

Ryan Aeronautical Photo

Consolidated subcontractors are located in all parts of the United States. Prominent is Ryan Aeronautical Co., which, in addition to subcontracting, is also important prime contractor producing training and combat planes. Importance of subcontracting is emphasized by this view of Ryan's modern plant devoted exclusively to manufacturing exhaust systems for leading United Nations aircraft.

Check LYON Facilities FOR FAST PRODUCTION OF AIRCRAFT PARTS IN ALUMINUM AND STEEL

- ✓ Class A Welders used exclusively for welding Aluminum and 40/30 Cromolley Steel.
- ✓ Welders trained in our own welders' school.
- ✓ 750-ton Hydraulic Press for production of large or small parts.
- ✓ Sciaky Welders for fast, accurate welding of parts under exact pressure and temperature control.
- ✓ Annealing and Heat Treating Equipment.
- ✓ All riveting done by thoroughly trained workers.
- ✓ Full complement of modern auxiliary tools includes:
  - (1) Routers.
  - (2) Band Saws.
  - (3) Shears.
  - (4) Brakes for Aluminum.
  - (5) Brakes for Cromolley Steel.
  - (6) Nibbling Machines
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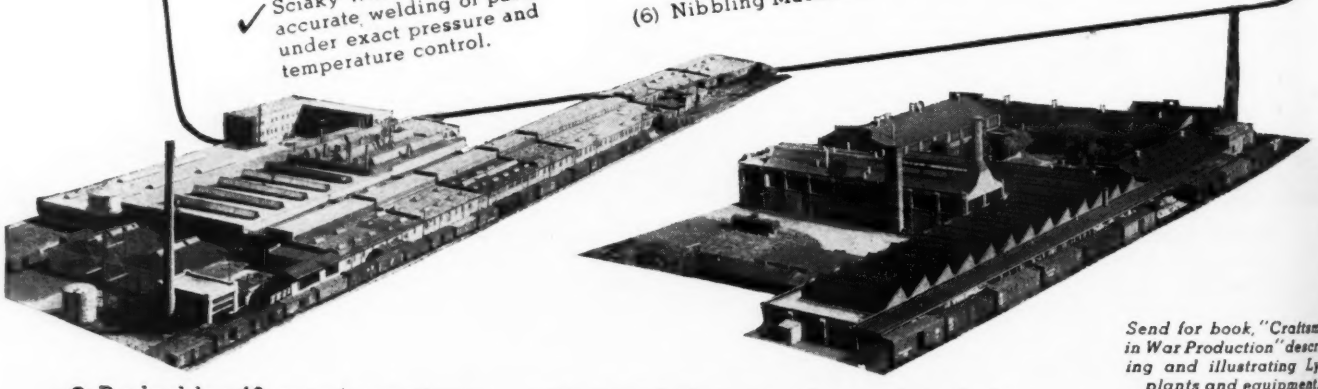

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Dick Whittington Photo

Constantly growing production of small parts, such as being welded here by feminine Solar Aircraft Co. worker, is as vital as output of major assemblies. Consolidated subcontracting set-up means complete coordination of both in- and out-plant schedules so finished aircraft can be delivered on time.

SUBCONTRACTORS SECTION

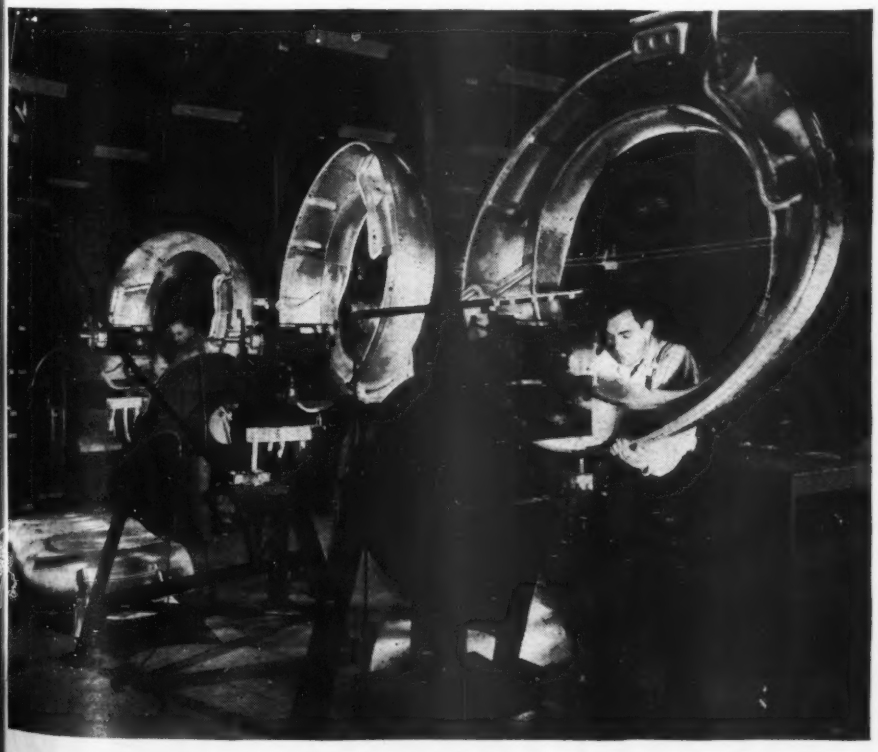
Consolidated now is subcontracting to over 100 major companies—to make parts for the B-24D *Liberator*, the C-87 *Liberator Express*, the PB2Y-3 *Coronado*, and the PBY-5 *Catalina*. These subcontractors are located all over the United States, which means that a finely correlated system has been set up to assure uniformity of product and delivery far enough in advance to keep the mechanized assembly lines in operation.

Practically all of the major components of the *Liberator* have been made in the company's plants up to the present time. However, the press of mass production, lack of available manpower in some California and Texas areas, and other factors make it necessary to arrange for more extensive subcontracting. Eventually it is believed that about 40 percent of the airplanes mentioned above will be built by subcontractors. The present percentage is far below this, but commitments to subcontractors are increasing steadily.

Going back to the period between 1929 and 1935, it is found about 5 percent of the components of aircraft was subcontracted. An acceleration occurred between 1936 and 1938 which brought an increase to 15 percent. The curve has been rising ever since.

Contracted for or actually in work are the following parts of the *Liberator*: Horizontal and vertical stabilizers,

(*Turn to page* 342)



Called for in Consolidated's subcontracting system is extremely close coordination of production schedules on "farmed out" parts—such as cowlings shown above being produced by Rohr Aircraft Corp.—to keep assembly lines moving despite increased demands. Such coordination is result of close cooperation between subcontractor and home plant personnel.

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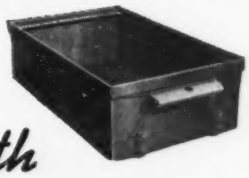

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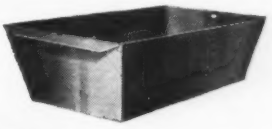

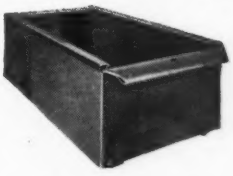

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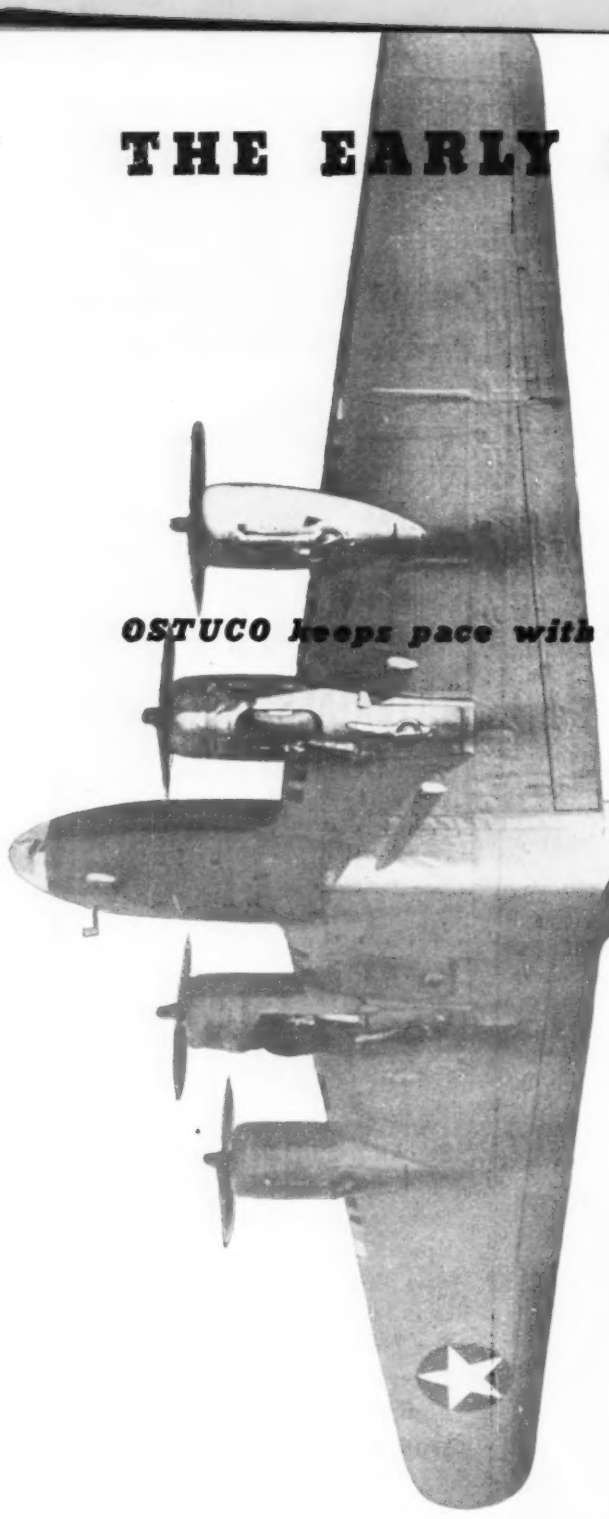

Boeing Flying Fortress
Photo Courtesy
Boeing Aircraft Company

OSTUCO keeps pace with More-in-Less-Time developments . . .

WHILE the aviation industry has been "early" with more-in-less-time production, it has also come through with "later" design developments months and even years in advance of expectations.

OSTUCO's job has been to keep pace with Aircraft and Aircraft Mechanical seamless steel tubing requirements to meet these production speed-up and advanced design developments. Specific applications in present-day planes include spark control, engine mounts, trunion bomb site mount, shaft and assembly door control, fuselage, stabilizer frame and many others.

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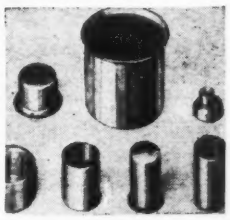

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Plastic Work S-144

Eastern New York state manufacturer has additional production facilities available for coating, impregnation, saturation, and bonding of fabrics or papers with oils, lacquers, or resins.

Precision Machine Facilities S-145

Philadelphia-area machine shop, currently employing 50 skilled machinists, has machine facilities open. For the past two years this company has devoted 100 percent of capacity to production for both Army and Navy Air Forces and is recipient of War Production Board Award of Merit. Machine banks having open time include: Automatic screw machines up to 1½ in. dia.; hand screw machines up to 1½ in. dia.; turret lathes up to 2¼ in. dia.; turret lathes—chucking up to 15 in. dia.; bench lathes up to 9 in. dia.; engine lathes to 18 in. dia.; milling machines, power fed up to size No. 2; and hand milling machines up to size No. 1.

Exacting Woodwork S-146

West Coast propeller plant, CAA and AAF approved, producing wood propellers, test clubs, aircraft flooring, etc., can take additional contracts such as wing and tail tabs and similar work. Principal equipment items include: A 132 in. profiling machine; a 125-hp. engine test block mounted on chassis; double and single spindle shapers; one light and two heavy drill presses; a heavy and a light band saw; an arbor saw; a DeWalt variety saw; a 12 in. joiner; large and small routers; one belt, one roller, one vibrator and three disk sanders; three balancing stands; two glue presses, 4x8 ft. and 1.6x9 ft.; complete spraying equipment; five 50 in. and two 100 in. surface plates, complete with tool, posts, and equipment; complete carving tools; and riveting guns, cutters, punch presses, and soldering equipment.

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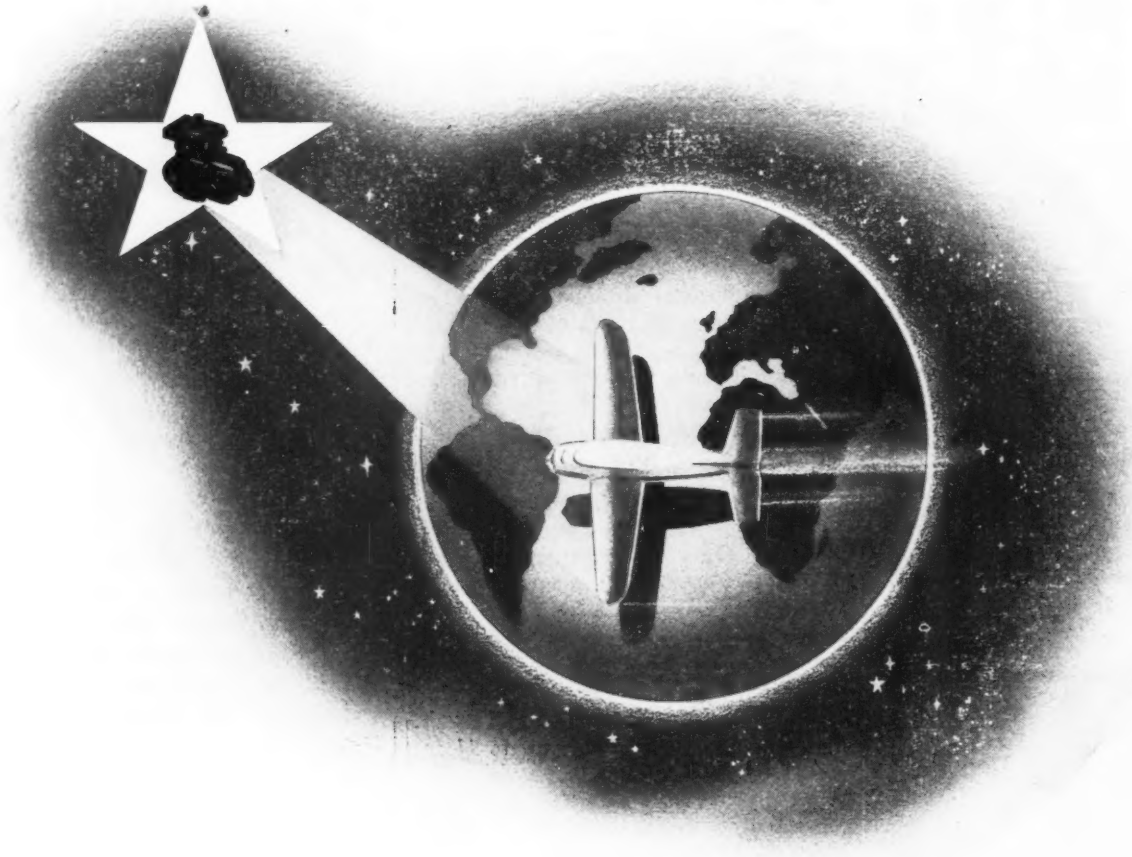

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SIDE SLIPS

WE HAD JUST ABOUT CONCLUDED it was safe to say that the aviation industry was here to stay when the politicians re-discovered it.

Now we wonder. If this "Freedom of the Air" business turns out to be a really good, permanent political football, there's no telling where the men who build the planes and the men who operate them will get caught.

As the Haggard Manufacturer said to the Haunted Airline Operator, "It will be okay if they let it go with a few new 'globaloney' and 'luce-talk' contributions to the nation's vocabulary, but if these self-appointed 90-day 'experts' decide to take over, I'll give you half my padded cell."

Got room there for another guy who's been in the business 15 yr. but still doesn't consider himself an expert?

• Miracles still happen. Other day a man went into Washington's famed Pentagon building, talked to three officers in three different places, and then got out—not only the same day, but the same morning! At 11:45 a. m. to be exact. He's had several offers, but is waiting to see if Congress raises the $25,000-a-year salary limit to see if it's worth while.

• Speaking of the Pentagon—as who doesn't who's been to the Capital— we thought those zoot suited escorts you follow around there were to keep people from getting lost. But no, they're part of the rules; no one without an employees' pass goes anywhere in the building without one.

We found out the hard way. Having learned to navigate from a particular office to an exit, we blithely started to play guide for ye editor and our publisher. No escort—bing, we land in the hoosegow.

Still think it's because their faces aren't so open and honest as ours, but who's going to tell his bosses that?

• A rather widely known aeronautic "expert" whose chief claim to fame was built on a book largely devoted to telling how lousy the American Air Forces are is now quoted by an English newspaper as advocating that we scrap all American fighter planes and build nothing but a single well known British type. Although that British type is one fine fighter, the only guys we know who'd really like the author's idea are Hitler, Hirohito, and Mussolini. Only thing they'd like better would be for us to use the author's ships—they've never, so far as we can determine, got beyond the "artist's conception" stage in the pages of his book.

• The American pilot in the Grumman *Wildcat* had everything on the Jap in the *Zero*—except ammunition. He'd already been in a fight and had used it all. But as the Jap headed right for him, firing, he decided he'd get one more son of the rising sun by crashing head-on and going down too.

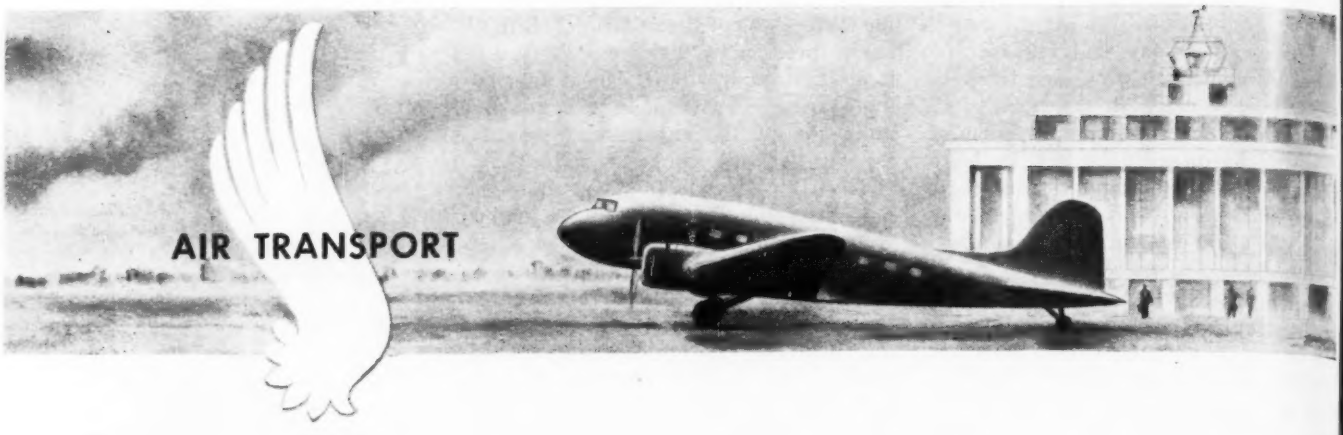
The Jap started to turn first—but not soon enough. His wing had just gone up when they hit. It was a terrific crash, and when the American looked back he saw the *Zero* wing fluttering off in one direction, the rest of the ship and the pilot spinning seaward. The leading edge of his own left wing was bashed in; it had a lot of new dihedral and cockeyed sweepback that Grumman engineers never designed into it. But it was still *on*. And it stayed on while he flew back to his base.

"Of course," said the man who told us, "he had to land kind of fast and he ground looped."

He can land it wide open if he wants, mister. We've still got a good pilot, some spare parts, and the knowledge that the guys and gals at Grumman are still turning out plenty of ships which are just as rugged as the one that brought him home to fight again.

• It certainly is nice that spring's reaching a well known fighter plane plant. One wag in the final assembly area has been complaining to his foreman about the cold. Says they open the doors so often to shove finished planes out that he's been frozen all winter.

Maguire has his own ideas on how to lick the absentee problem



Postwar Preview Of European Airways

By MAURICE A. GARBELL, D. Sc.
Member, International Research Committee for Motorless Flight

Food for thought is the network of potential routes designed to speed rehabilitation of continent and assume ultimate peace-time role.

THROUGHOUT the United States, planning in the "twenty-fifth hour of the day and on the eighth day of the week" has transcended the stage of discussion. Far from retarding production dedicated to the immediate war effort, constructive thought projected into the future creates the stimulating pause which enables the man behind the man in the cockpit to steer a steadfast course while "on instruments through heavy thunderclouds."

It is reasonable to conjecture that the present conflict will lead to a collapse of the Axis on the European scene, which will initiate a period of reconstruction in Europe while the struggle in the Western Pacific enters its decisive phase. Japan, in spite of heavy shipping losses and other difficulties, will, we assume, have been able to organize and exploit at least part of the victims of her aggression. It will then be imperative for the United Nations to shift their military power with the greatest possible speed to the Pacific theater of the war.

The reconstruction of Europe must therefore be achieved rapidly and economically in order to eliminate a constant risk of further drain of energy through internal and external explosions on that Continent during such a critical period for the United Nations.

Our training of a future corps of governors, technical advisers, and political organizers to assist in an immediate reconstruction of the European continent does not come as a surprise to those who recall that, after World War I, open warfare raged throughout certain parts of Europe for at least two years (1918-1920) despite the officially concluded peace. Apart from the human considerations for the welfare of the hundreds of millions of homeless and suffering Europeans, the Continent must be reorganized rapidly and efficiently to eliminate a menace to our Atlantic rear and to gear European industrial and agricultural production to our own war efforts in the Pacific.

Air transportation's role in such a program of reconstruction and reorganization needs no discussion. Air cargo has become a vital element in military and logistic operations. Equally, if not more important, is air transportation of essential military, technical, and political personnel.

With all due respect to our valiant Allies among the Continental Nations beside whom we are fighting on land, on and beneath the sea, in the air, and "underground," we must anticipate a rather indifferent or perhaps hostile attitude of many Europeans toward an American-British-Russian effort to rebuild Europe. Our lines of communication in Europe will have to be immune to sabotage and able to function under any condition of local unrest, natural or man-made catastrophes, such as floods, forest fires, etc., and under the most adverse weather conditions.

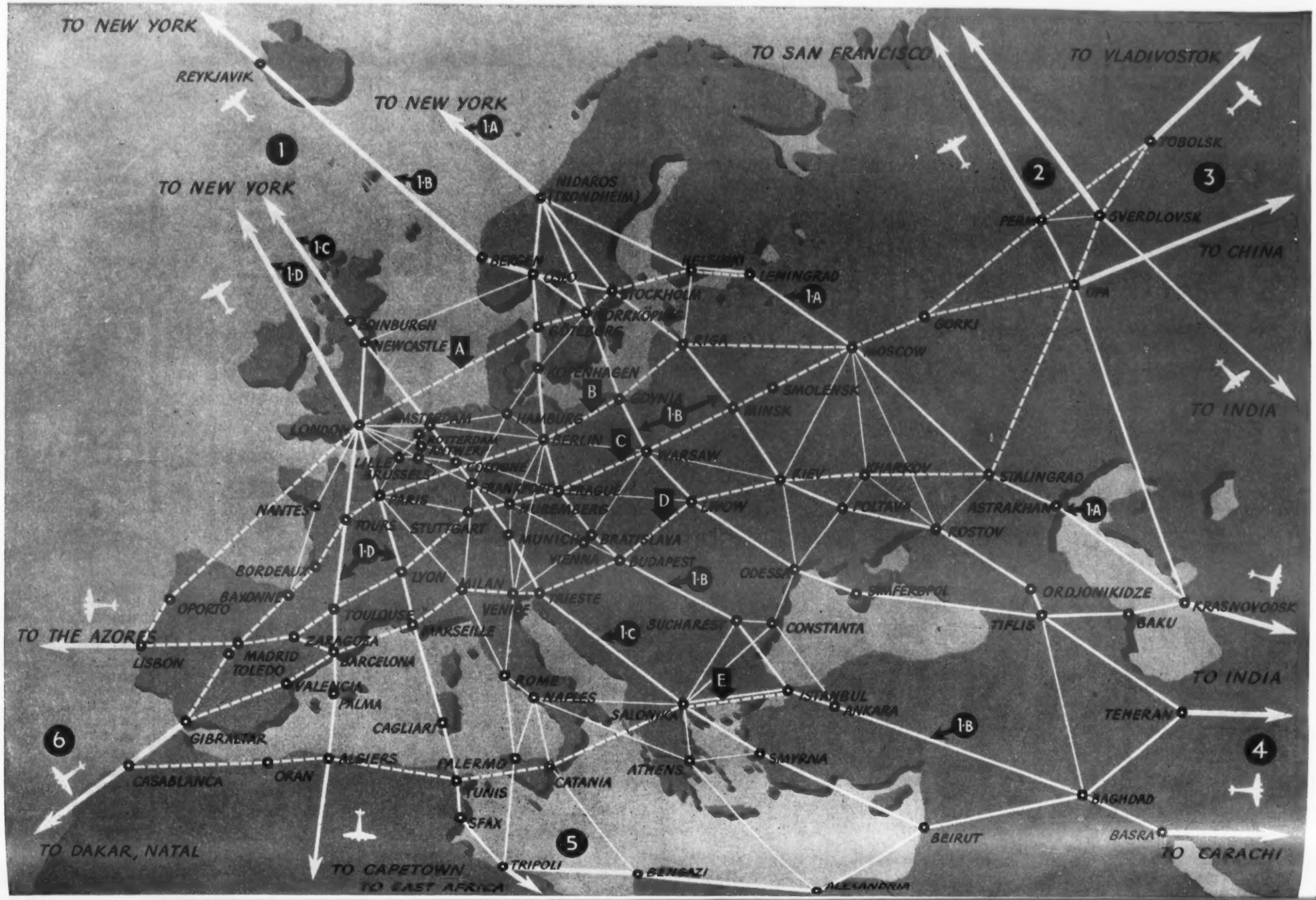
This means, of course, that a system of European airways will have to be established and maintained. A speculative discussion of such airway system is attempted in this article.

The prewar airways of Europe, despite a few transcontinental and transoceanic lines, were primarily based upon short-range luxury transportation between important cities of the Continent. Meteorological assistance was good, but instrument flying was limited by the non-existence of radio range stations and the insufficiency of airway traffic control which was, at best, spotty. Political difficulties added numerous other problems to the complications of prewar air traffic in Europe.

The new European airways system will be essentially of global and transcontinental character, similar to that of the Americas. Europe's key position as a crossroads will be accentuated in the event of a prolonged Pacific conflict. Our accompanying map illustrates

(*Turn to page* 337)

• *The routes outlined in the accompanying article are thoroughly familiar to Dr. Garbell, who covered practically all of them during his years as a designer and as a member of the International Research Committee For Motorless Flight. Since coming to this country early in 1939 he has been affiliated with the Boeing School of Aeronautics and is now with Consolidated Aircraft Corp.*


TO NEW YORK
REYKJAVIK
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TO VLADIVOSTOK
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SVERDLOVSK
TO CHINA
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LENINGRAD
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TO EAST AFRICA
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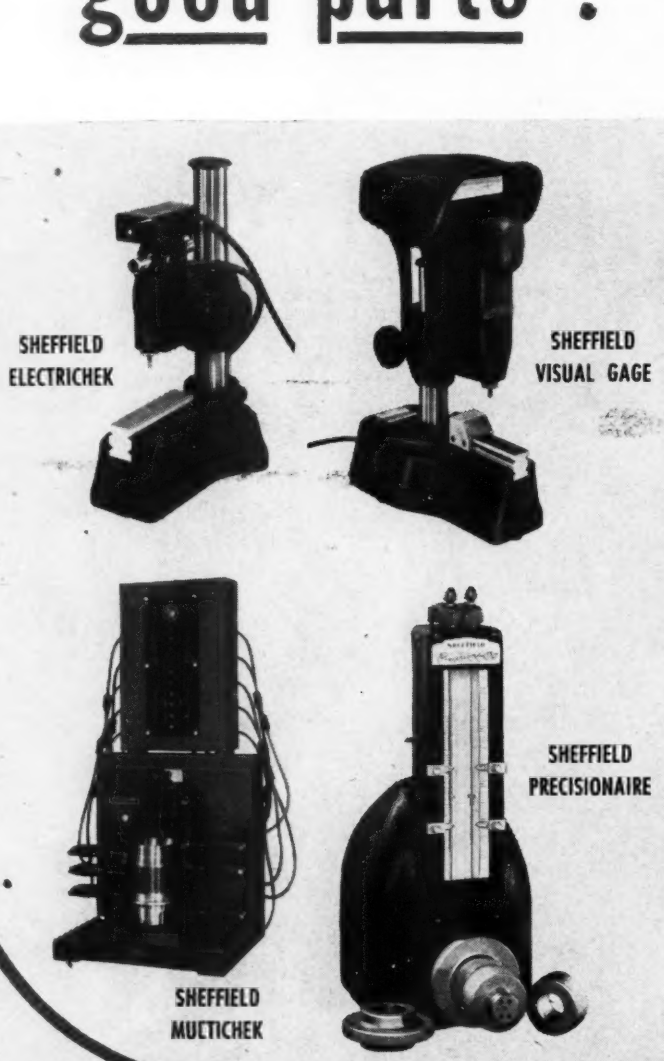
ALEXANDRIA
TO CARACHI

don't let faulty inspection cause you to scrap good parts . . . . . .



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Shifting Prospects For Airline Revenue and Profits

By RAYMOND L. HOADLEY
Financial Editor, "Aviation"

New light has been thrown on air carrier securities position by analysis of effect of excess profits tax—overlooked by many investors—possibility of fare reductions, mail pay cuts, and war contracts.

WALL STREET and the investing public generally have been so enchanted with the future growth possibilities of the domestic airlines—and rightly so—that scant attention has been paid to the revenue and earnings outlook for the next year or so.

The blunt fact is that the upward trend in revenues will not continue at the amazing rate witnessed in 1942, and increasing tax burdens may cause a decline in profits from last year's peaks.

This means that the investor who buys airline shares at or near the highest 1942-43 levels is paying the premium usually demanded for the so-called "growth" stocks and he cannot count with any surety on the continuation this year, and possibly in 1944, of the recent upward climb in revenues and earnings. Nor does it appear that generous dividend returns on airline equities are just around the corner.

The airlines achieved unexpectedly good results in 1942, but some recession is looked for this year by most competent trade observers. There are, however, so many "ifs" in the picture that they are not disposed to be dogmatic in surveying the outlook. Here is the way the situation stacks up at present.

First take revenues. The huge gains registered after Pearl Harbor in passenger and express traffic have slowed up appreciably. And, since the government requisitioned 50 percent of the airlines' transport planes last June, the gains in both of these revenue sources have been largely in the categories of scheduling full passenger loads (today, load factors run as high as 95 percent at times, whereas 60 percent was considered eminently satisfactory before the war) and improved methods of loading freight. Then, too, the express demand may drop considerably in some instances due to changing war production conditions.

Building construction and plant equipment, for example, will be materially lessened as the war program moves out of the expansion stage by this coming summer. There will be less need to rush materials, tools, and machinery by air express to new war plants. Thus the spectacular upward curve in express shipments since Pearl Harbor appears to be flattening out.

At the same time it appears quite probable that passenger fares will be reduced in the near future, either voluntarily by the airlines themselves or through pressure by the Civil Aeronautics Board. The CAB has repeatedly stated, in recent mail rate decisions, that the air carriers should give early consideration to passenger fare reductions. Thus there is the anamalous situation where a government agency is agitating for a cut in fares at a time when such a reduction cannot induce more air travel because of the limited available seat capacity.

Fare Cuts Possible

Last year the airlines, in effect, boosted passenger revenues by 9 or 10 percent by eliminating discounts. What they are most likely to do now, as a result of the CAB pressure, is to make a reduction in fares by about that margin. Such a reduction—if and when it comes—will tend, of course, to lessen passenger revenue which is already limited by the ban on new equipment.

Should the government suddenly decide to make available more transport or cargo planes for the airlines' commercial operations out of the several thousand now on order, the picture could change almost over night. But while this is a possibility rating some consideration, trade observers are not at all optimistic that it will be done—owing both to the continued critical overseas shipping shortage and the promised establishment of additional war fronts in Europe within the next eight months.

The increase in airmail volume goes on at a rather amazing pace and may well show a considerable gain this year over 1942. But here, too, there is an offsetting factor. The CAB has reduced airmail pay of most of the airlines. Reductions for five of the largest domestic air carriers aggregate more than $6,000,000. This is in line with the government's policy of squeezing out the air mail subsidy as fast as the airlines demonstrate their ability to operate profitably without it.

Turning more directly to the earnings outlook, one finds that wartime taxes have become the paramount factor, just as they did two years ago for most American business. For several years statisticians have taken pains to point out how favorably situated the airlines have been on the tax question. Unfortunately that is no longer true. For the first time many of them are reaching the excess profits tax brackets. The revenue acts of recent years have been designed by Congress to aid the airlines in buttressing their financial positions up to a certain point. But now that point has been reached and the airlines are finding the excess profits tax is about to hit them with a vengeance.

This is the way it works out: The section of the 1942 Revenue Act dealing with the airlines (727-h) says in essence that airlines are exempt from the excess profits tax when their *non-mail* adjusted net income is zero or less. In the case of an airline, adjusted net income means net income *less* the line's (1) excess tax credit based on invested capital; (2) any carry-over from the two preceding years of unused invested capital credits; and (3) the usual $5,000 specific exemption.

For example, an airline might have non-mail net income of $900,000 and a total tax credit of $1,000,000. Obviously, its adjusted net income here is zero or less, so the airline is exempt from excess profits even though its mail revenue might have been, say, $5,000,000. Thus the airline in this case would have a total normal corporate and surtax net income of $5,900,000, which would be subject to the combined tax rate of 40 percent. Federal taxes, therefore, would amount to around $2,360,000.

Now to alter the above example a bit, assume that non-mail net income was $1,100,000 with the same credit of $1,000,000. This would leave adjusted net income of $100,000 which, of course, is more than zero. In this instance the airline would have an adjusted net in-

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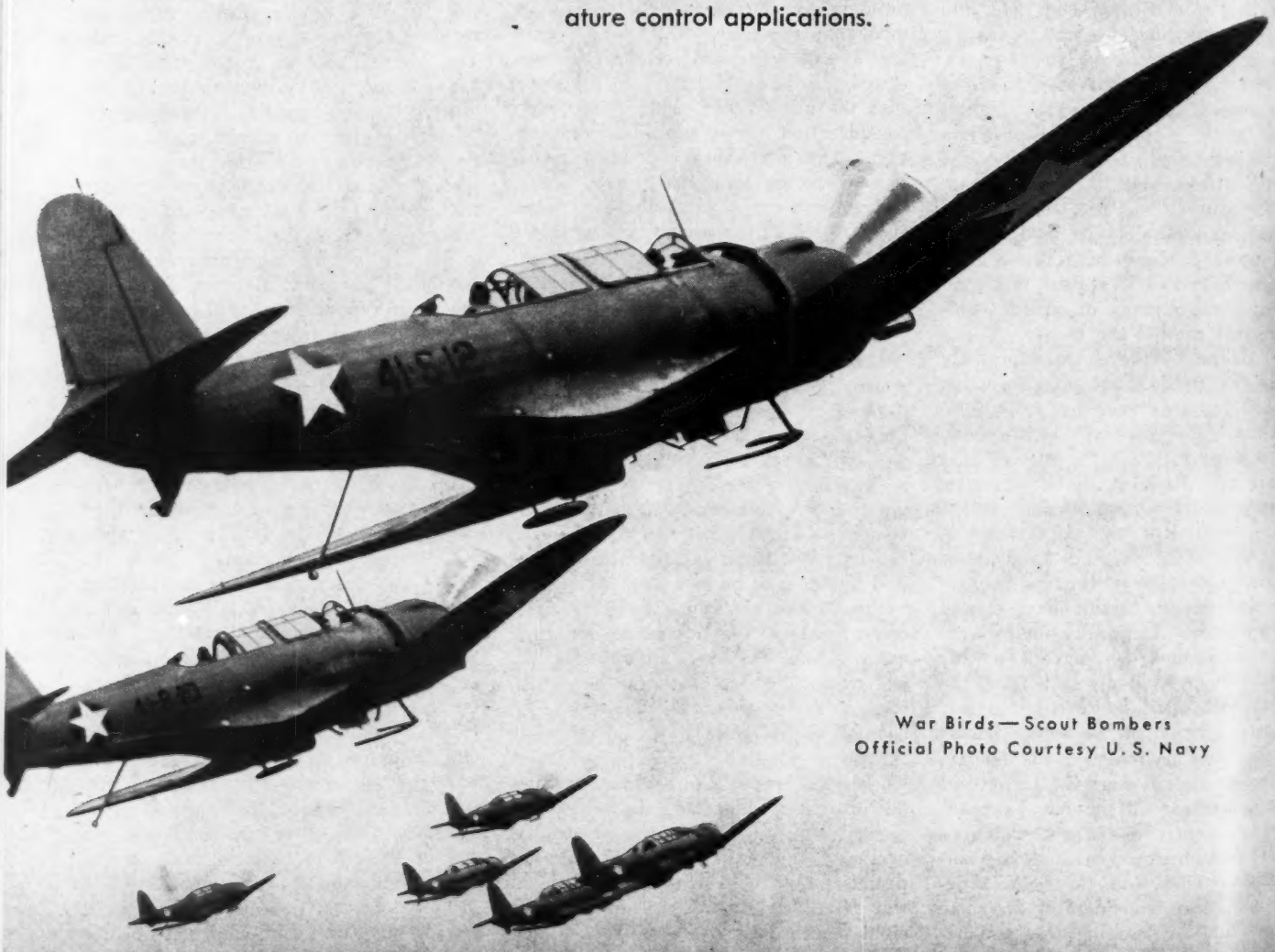
1. **Engine cowl flaps (both air and liquid cooled).**
2. **Oil cooler shutters or flaps.**
3. **Cabin temperature (both super-charged and normal).**
4. **Carburetor air temperature.**

Upon request, engineering data will be furnished to manufacturers requiring controls for the above or other temperature control applications.



War Birds—Scout Bombers
Official Photo Courtesy U. S. Navy

WHITE-RODGERS ELECTRIC COMPANY

SAINT LOUIS MISSOURI

come of $6,100,000 less the $1,000,000 credit—or $5,100,000 which would be subject to the excess profits tax rate of 90 percent. Federal taxes would amount to around $4,590,000 That means that on a gain of $200,000 in non-mail revenue, taxes have jumped—by $2,230,000 in the example cited.

In other words, if airmail pay is subtracted from adjusted net income and a profit of even 1c is left, then the airline is subject to the 90 percent tax on all income, including airmail, instead of just the 40 percent tax. No wonder, then, that the CAB pointed out in recent mail-rate decisions that excess profits taxes would cut down airline earnings.

Fact is that an airline conceivably can earn more profit for its stockholders if its non-mail operations are just at the break-even point than it can when a profit can be shown from non-mail sources. Such companies as American Airlines, Braniff, Eastern Air Lines, Transcontinental & Western Air, and United Air Lines are understood to be in, or closely approaching, the excess profits tax "area."

A lot will depend on how the Bureau of Internal Revenue interprets the law now that this situation is coming up for the first time. And it is entirely possible that excess profits tax provisions, as they affect the airlines, may be changed in the pending 1943 revenue bill if Congress becomes convinced that undue hardships have resulted from the current law.

It should also be pointed out that the airlines are less favorably situated with respect to excess profits tax exemptions or credits than the average industry. Being one of the youngest American industries, albeit a lusty youngster, the airlines do not have very large invested capital like some of the oldsters—the railroads, for example.

Even so, the airlines invariably choose the invested capital exemption base rather than the alternative average earnings base, which is figured on average earnings for the years 1936 to 1939. While most industries had fairly stable earning power in those years, the airlines generally operated in the red or close to it.

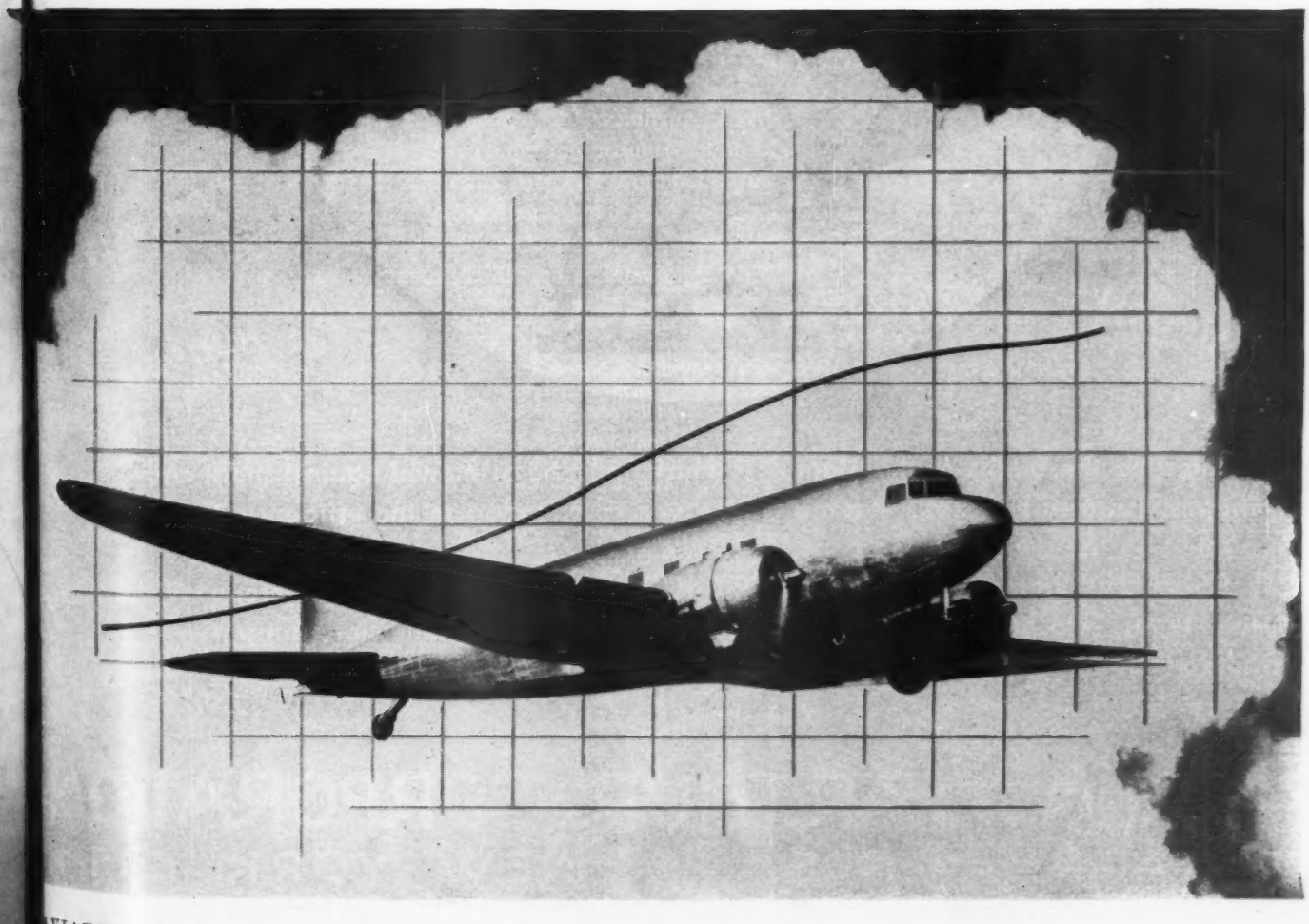
To temper the drastic excess profits tax rate, there is a provision in the revenue laws permitting a company to carry over its unused excess profits tax exemption for two years. Assuming that an airline company did not use all its exemption in 1941 or 1942, the credit presumably could be used as a tax offset this year. However, it has not been entirely clear how the Internal Revenue Bureau would interpret some points in this provision. Should airmail pay, for instance, be deducted in determining whether or not the credit has been used up?

In the realm of state taxation, too, a recent decision by the Supreme Court of Minnesota has given airline tax experts something over which to ponder. By that decision, Ramsey County, Minn., was permitted to tax the entire fleet of Northwest Airlines. The majority opinion stated that the state has the power to tax the NWA fleet "so long as no part of it is permanently located in another state."

This is the first time that a company's entire fleet has been taxed by the state in which its headquarters are located. The decision brings up the question whether or not, for instance, the five states over which planes fly (but do not stop) on a New York to Chicago air route, could properly levy taxes on the carrier's planes.

Here may be the opening wedge of state-imposed artificial burdens on air

(*Turn to page* 407)



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Warren McArthur Model Number 225 Pilot's Seat with Upholstery

"Protecting the brains of the planes"—which must be cushioned against shock and fatiguing pressures. That's Warren McArthur's contribution to the efficiency of our fighters in the air.

Scientific seating—so vital to safety of crew and plane in long dangerous military flights—so paramount to comfort of passengers in commercial transport—is now essential equipment in American air squadrons all over the world.

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PILOT'S · CO-PILOT'S · NAVIGATOR'S · RADIO OPERATOR'S · REAR GUNNER'S · CAMERA OPERATOR'S · FLIGHT ENGINEER'S · NAVY PATROL STEERSMEN · BOMBARDIER · WARDROOM · OBSERVATION AND TRANSPORT SEATS

At unnamed airfield in Nicaragua, sacks of crude rubber are loaded into United States Army plane to make payload of strategic importance to United Nations. Other scrap rubber is picked up at airfields in Panama and Guatemala, then flown to San Antonio by Army planes returning "light" from Latin American missions.

Rubber Takes To the Air

Today, rubber has become one of the principal cargoes on air routes from Central America.

More than 100 tons of crude rubber have been flown to the United States from Central America alone since early in Dec. 1942. Utilizing space in northbound planes, the crude rubber is coming in increasing quantities from airfields situated deep in the American tropics. More than half of the airborne tonnage has come from the Republic of Panama. Most of the remainder has been from the Canal Zone and Nicaragua, with a few tons from Guatemala. From the Canal Zone the rubber thus far brought is seized enemy rubber, now put to work to help defeat the Axis. The remaining crude rubber known in is in the form of "tree scrap" from the wild Castilloa trees of Central America—coagulated latex that collects at the base of the Castilloa tree after tapping it in herringbone fashion. It is of a lower grade than the smoked sheets of Castilloa prepared from more carefully colleced latex that has been first screened free of impurities and then cured by smoking. The tree scrap brings the basic Rubber Reserve price of 33c a pound.

Throughout the Castilloa region, the rubber gatherers assemble tree scrap and bring it to the airfields. Army planes returning north from the Canal Zone pick up the scrap rubber in 100-lb. bags and bring it to San Antonio, Tex. A plane may load as much as 4000 lb. of scrap rubber along the northward route, depending on space available.

The tree scrap now being flown out of Central America represents only a fraction of the over-all rubber development in those countries. The area contains millions of wild and semi-wild Castilloa trees, with many operations being conducted according to modern methods of screening and curing the latex to produce a higher grade of crude rubber. Thus, the tree scrap collection is only the beginning of a vast development of Central American rubber production expected to yield long-range benefits as well as furnish an immediate wartime source of this strategic material.

Ranging the tropics for every source of rubber, the chicle workers of Central America are also gathering Castilloa rubber. From Guatemala and Yucatan, the planes which have been carrying chicle for chewing-gum from inaccessible forest regions to river ports are now serving to bring out Castilloa rubber as well.

The Central American republics are among the 17 American rubber-producing countries that have agreed to sell their exportable surplus of rubber to the Rubber Reserve Co. The contracts, running to 1946, set prices ranging from 33 to 45c a pound and provide for long-range development of the rubber industry in the Western Hemisphere. Other planes throughout the vast Amazon River basin area are engaged in handling crude rubber from the Hevea tree in the continent's major rubber program initiated since the wartime loss of Far Eastern rubber sources.

Complete Mobile Fire Protection Units

To fill the need for the right kind of fire fighting equipment when and where it is needed, Operations Engineer Roland Lewis, of Braniff Airways, designed these one-man fire carts.

The truck chassis are airplane battery carts which had been discarded for improved models. Small but very compact, they hold all the following items: Asbestos suit, fire axe, crowbar, bolt cutters, shovel, welder's gloves and goggles, Pyrene powder, 2-lb. CO_2 extinguisher, 2½-gal. foamite extinguisher, flashlight, iron pail, 200 ft. of sash cord, and a first aid kit.

Built under supervision of Crew Chief Frank Stucker (center) by mechanics Jim Handley (left) and Bill Sturges (right), the trucks are placed at good tactical stations about the base.

TURNING THEM OUT *Faster*

IN MEETING the Government's goal of 10,000 planes a month, improved machining practice has been continuous.

A recent example is the machining of aluminum and magnesium alloys in engine plants, where an entirely new cutting coolant is permitting faster cutting speeds ... *Texaco ALMAG Cutting Oil.*

Equally suitable for both *al*uminum and *mag*nesium, *Texaco ALMAG Cutting Oil* adequately cools and lubricates the cutting tools, prolongs their life, increases cutting speeds, steps up output. *ALMAG* is transparent, permitting the operator to *see* ... and is non-irritating to the skin.

So effective have Texaco Lubricants proved that they are definitely preferred in many other important fields, a few of which are listed below.

A Texaco Lubrication Engineer specializing in cutting coolants will gladly cooperate in the selection of the most suitable lubricants for your equipment. Just phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write:

The Texas Company, 135 E. 42nd St., New York, N.Y.

THEY PREFER TEXACO

★ More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.

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TEXACO

TEXACO Cutting and Soluble Oils

FOR FASTER MACHINING

MAINTENANCE

• It is not only the excellence of an airplane which determines its effectiveness—for the best of craft, when grounded through abuse or lack of knowledge, are of no use to anyone. The tremendous expansion achieved with the well known makes of automobiles was due as much to the organization of supporting service chains as to the inherent value of the product. In this article, one of the first men to apply this philosophy to the aircraft industry makes clear the value and need of organized service by the manufacturers.

Aircraft Service Organization The Gateway to Sound Operation

By ARTHUR L. FORNOFF
Director of Service, Bell Aircraft Corporation

Definition: Service Man—
One whose work is servicing.

IF YOU DON'T BELIEVE IT, look it up in the fattest dictionary you can find. But my advice is never to spring that one on an aircraft service man, particularly one who's been on foreign assignment where he has had to work as many 24-hr. stretches as his tired body can stand, often laboring without parts or tools to make the parts—intent only on getting his company's aircraft back into the air.

Part mechanical wizard, part diplomatic ace, part iron man, part topnotch design engineer, part writer of technical reports . . . add generous amounts of Yankee ingenuity and inventiveness, and spice with a balanced sense of humor, and you have—the Service Man!

But what I want to discuss is the organization which has to be established and whipped into smooth operation before any aircraft company can send trained service men out into the field and have the most good come from their efforts—the most good to the customer, Uncle Sam; the most good to the parent company, which has to draw heavily upon the knowledge of its service men in order to make next year's aircraft better.

It was recognition of this importance of a well organized service department to the continued efficient functioning of combat aircraft which led to formation of the Service Committee of the East Coast War Production Council, of which I have the honor to be present chairman. With this problem looming large on our present horizons, early meetings of this Service Committee have brought into a new perspective the hitherto ambiguous position of service men trying to follow up their planes in the field without due recognition and authority from either their own companies or the military units using their planes.

Taking as an example the organization at Bell Aircraft, the service effort has more than justified itself. As shown in the accompanying chart (Fig. 1) it is a full department of the company, on a par with Engineering, Design, Production, and Contract. The reason for this footing lies in the Service Division's immense usefulness through its compiled records of everything that

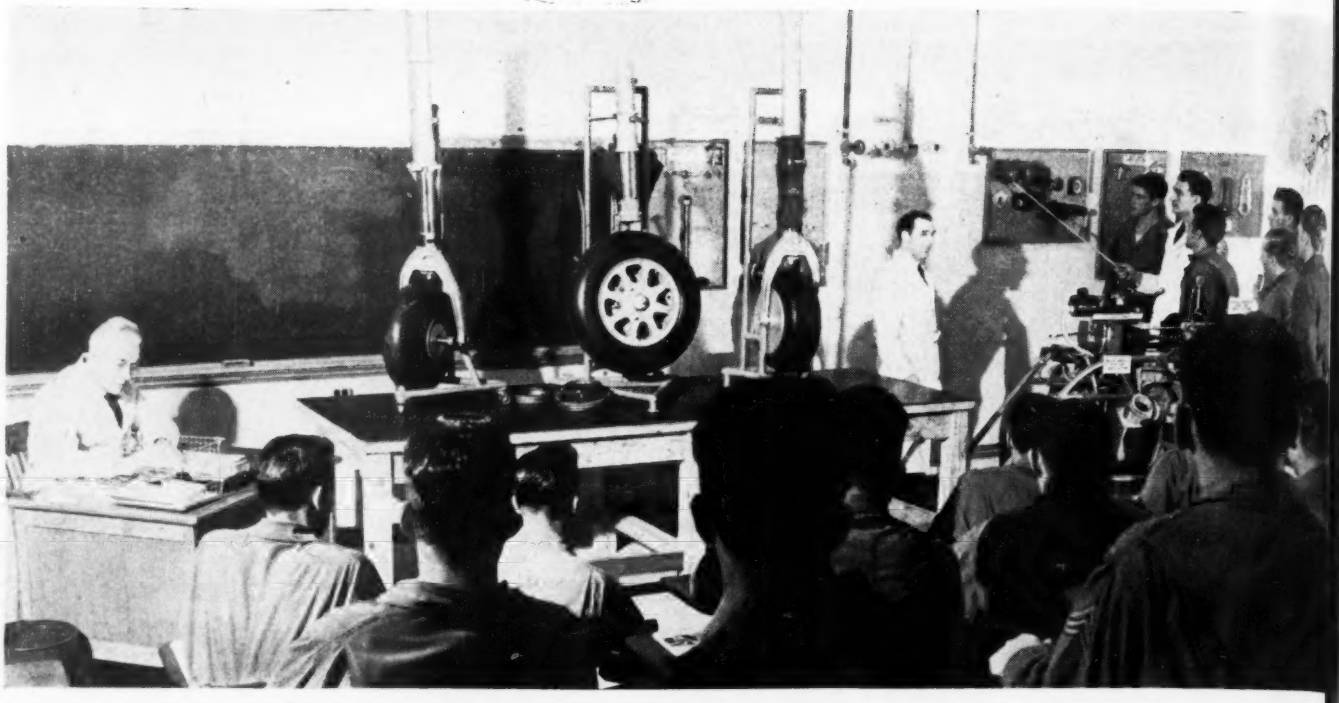
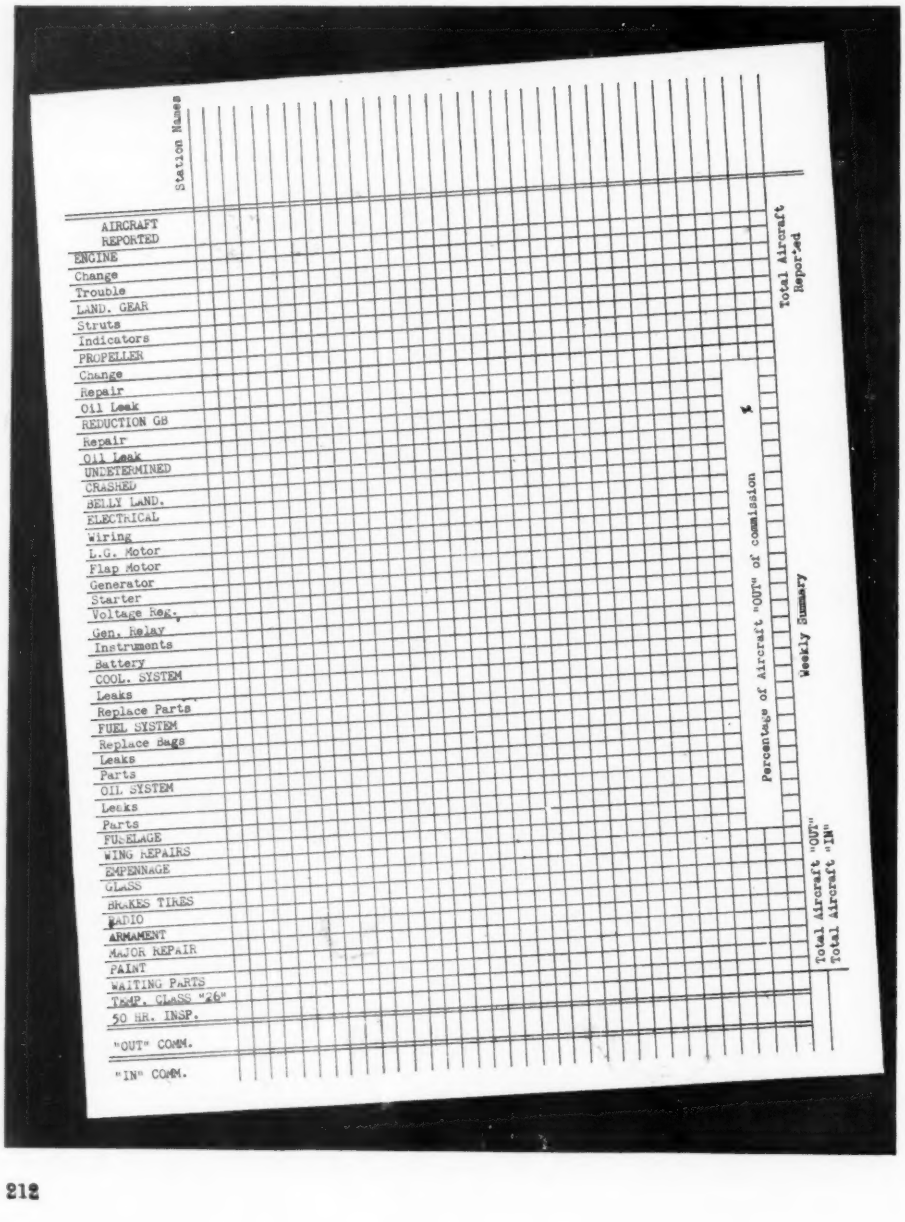


Fig. 3. In a six weeks course packed with study, these men are trained on practical equipment. Thorough groundwork here keeps more planes in the air outside.



has happened to the planes in the field.

In contrast to the departments whose function lies within the plant, the Service Division takes over the minute the plane leaves the factory. Service technicians, trained at Bell by standard methods established on experience, follow their craft all over this country as well as through 25 stations throughout the rest of the world.

It has taken a great deal of work to build the system to this point, but consider the value of the combined information which is always at hand.

Every day each service man sends in his report—from wherever he is, be it from the farthest fighting front, and by whatever mail runs—covering all his company's planes in the locality. This information is broken down into a detailed analysis of every aspect to be considered. A continual summary of this information at the home office makes always available a picture of the status of all equipment in the field, as well as an unbroken record from which troubles may be analysed and corrections undertaken.

The form reproduced in Fig. 2 is one of many breakdown summaries. Take, for example, an unduly large number of propeller changes at a particular base. This calls for an inquiry as to the reason. We find the service man having to replace bearing cones with a newer type. A recommendation from him immediately transferred to the production

Fig. 2. Form for weekly summary of reports turned in by company representatives. This gives at a glance an over-all picture of maintenance status.

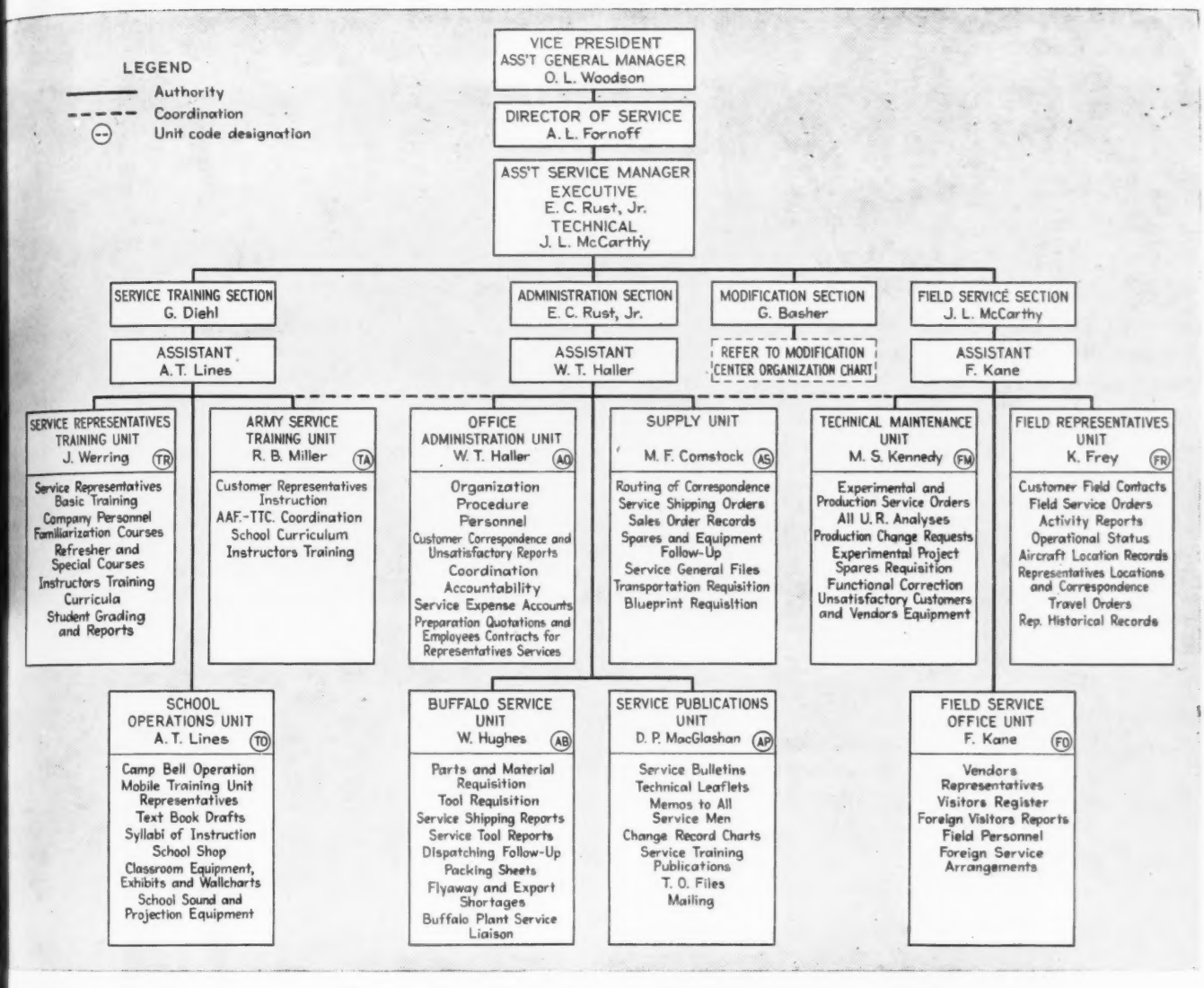


Fig. 1. Service organization chart, Bell Aircraft Corp.

ine to install the proper new cones remedies this fault at its source and aves tie-ups in time and parts shipment.

A large number of landing gear failures at any given station calls for an immediate investigation by a specially trained technical maintenance service representative. On arrival, he talks with the pilots to find out the conditions of operating, and watches their use of the equipment. He may find that some are bringing the ship in hard nose down at 125 mph., others stalling in, flaps down, at 90. In other words, using no proper standard procedure suitable to the equipment—and every model has its own peculiarities, requiring treatment designed especially to cope with them.

In a case of this sort lies the service man's most delicate task. He will probably have to approach the matter indirectly in this fashion: "We had a situation like this at another field, and we found a way to remedy it. Here's what we did—"

(*Turn to page* 355)

Fig. 4. On a jacked up plane, all mechanisms are studied and put in operation. Complete familiarity with every detail of their plane will make these men invaluable when it comes to question, "How can we get her flying again?"

Dynamic Balancing In Propeller Maintenance

MAINTENANCE

By B. J. CUMNOCK, *Senior Maintenance Engineer, Braniff Airways*

Diagram and plotting system provides means of attaining perfect dynamic balance on first attempt 90 percent of time. Eliminates guess work, saves time.

IT IS IMPOSSIBLE to remove all traces of dynamic unbalance during engine overhaul. Such unbalance varies in magnitude due to manufacturing tolerances and different combinations of crankshaft, damper, connecting rod, link rod, and assemblies. Slight changes in mounting and even removal and replacement of propeller dome can cause unbalance in themselves and must be counteracted to achieve smooth engine operation.

The propeller balancing diagram in Fig. 1 shows a systematic method of determining the number and location of lead disks to be added in the hollow balancing bolts of propeller hub.

A small metal vibrometer (Fig. 2) is attached to the top of the control column. At the speed which causes the greatest amount of sympathetic vibration in the column, the extent can be read on the vibrometer. The latter vibrates from side to side, giving an optical effect of a "V", of which the point is the measure of unbalance. As roughness increases, this point of the "V" moves down scale, with readings given in tenths of inches.

Having determined that unbalance exists, it is necessary to find out where to place the lead disks for counter weights. To distinguish between propeller blades, each one is wrapped in turn with three windings of common adhesive tape at a point about 18 in. from tip of blade, thus causing an unbalance of known degree and location. Blades are run up separately and the reading for each particular blade is plotted on

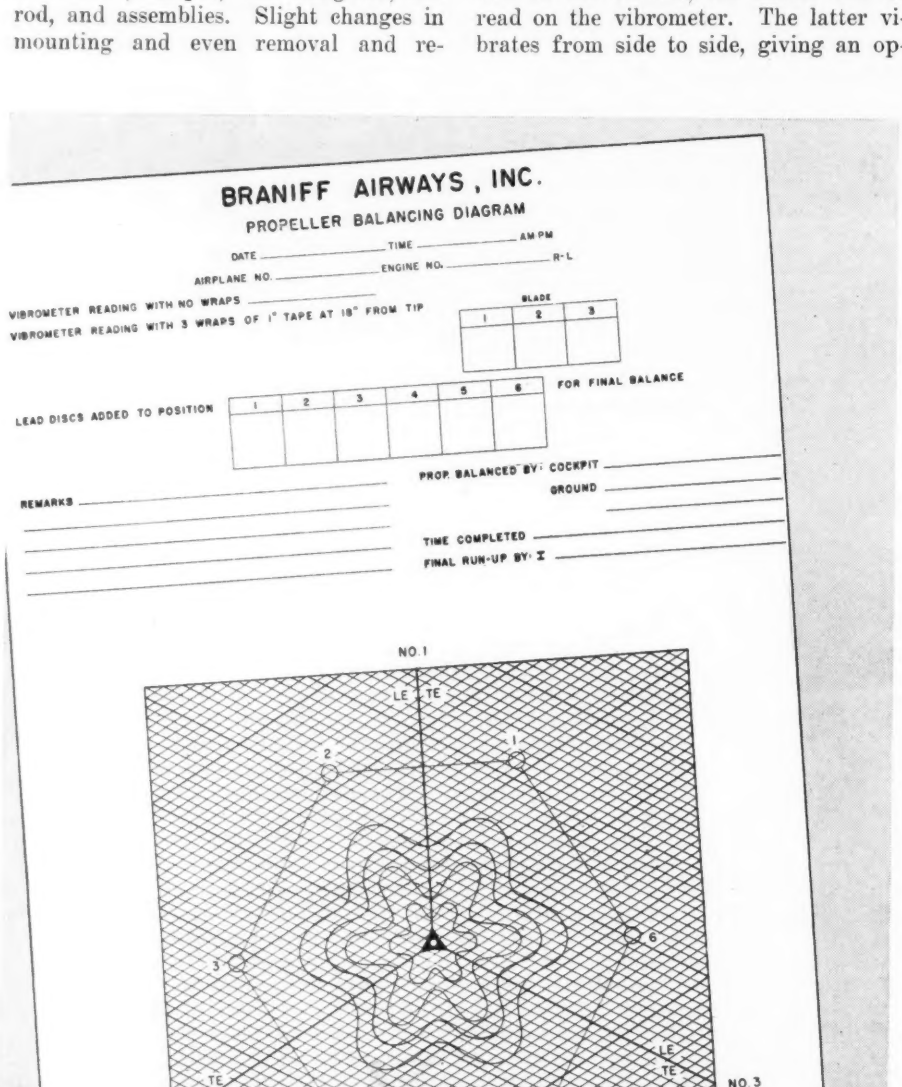


FIG. 1

FIG. 2
Propeller Balancing Vibrometer

the diagram in tenths of inches. Readings for No. 1 blade are measured on a vector vertically up blade, those for No. 2 along a vector parallel to No. 2 blade and those for No. 3 along a vector parallel to No. 3 blade. A line is drawn from the end of the third vector through the center of propeller and is extended until it intersects the hexagonal hub. To the nearest bolt, or bolts, the correct amount of lead is added to balance propeller.

Amount and division of this weight is calculated according to the scalloped graph lines around center of hub. These were plotted by use of the formula for rotating bodies. Assuming an unbalanced force and assigning a definite relation between it and a balance bolt will produce these outlines, when introduced in the formula. When a plotted

(*Turn to page* 403)

Pegasus was a piker!

• Not even in the wildest flights of fancy does the winged horse of mythology compare to the everyday miracles performed by the great flying boats of Pan American Airways.

But Pegasus had one advantage! He didn't have to fret over the problems of supplies, parts, repairs and the myriad details of maintenance that make Pan American's world-wide operations all the more remarkable in their amazing efficiency.

Valspar is quite proud of the fact that this far-flung airways system uses certain Valspar Val-Aero finishes at its bases in New York, Miami and Rio de Janeiro.

In its uninterrupted use of these fine finishes P A A inspections show Val-Aero stands up under severest service—delivers complete satisfaction in every respect.

What Valspar Val-Aero Finishes do for P A A—they can do for you.

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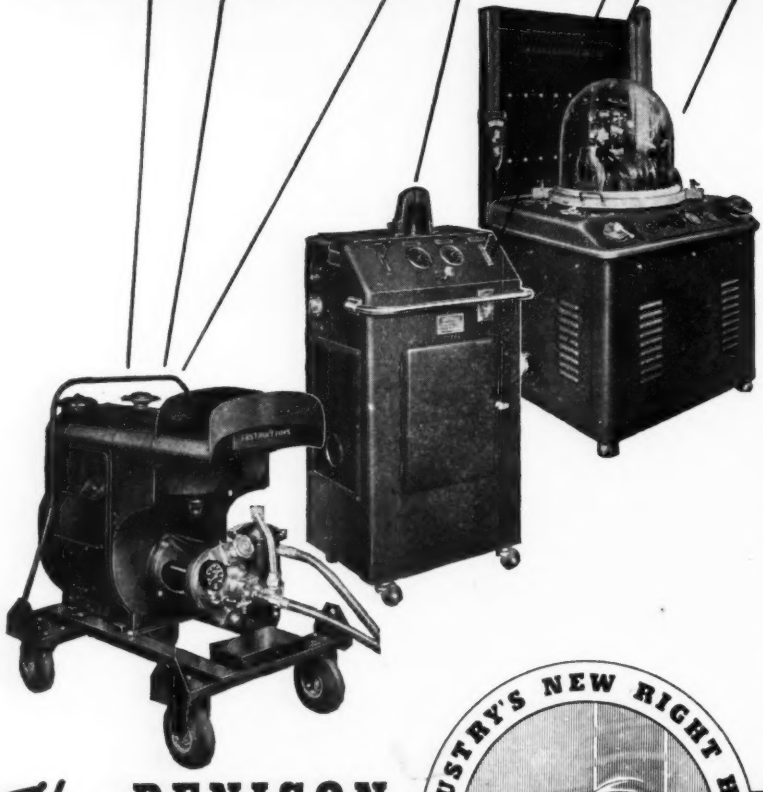
TAKING TEST FLIGHTS ON THE GROUND



The *flight performance* of many of the most vital *functional* parts of an airplane can now be accurately foretold — by tests made on the ground.

HydrOILic Test Stands are making these time-saving, life-saving tests possible — at aircraft plants, commercial depots and military air bases.

Three typical test stands are shown at left. One checks spark plugs for electrical leaks . . . another tests magnetos at almost any temperature, speed, air pressure or humidity encountered in the skies . . . the third checks vital hydraulic systems to make sure that ailerons, rudders, brakes, bomb bay doors, landing gear, and propeller controls will work correctly in the air.

Aviation is only one of many fields in which Denison Engineers have applied the exceptional smoothness, flexibility and controllability of oil-hydraulic power. If you have a problem involving wartime or peacetime products or production, our engineers may prove extremely helpful. Call your Denison representative, or write us.

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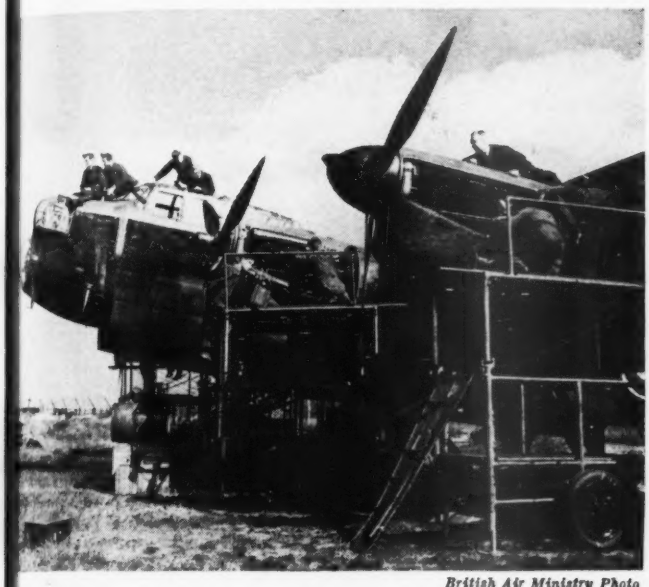
DENISON
EQUIPMENT in APPLIED
HydrOILics

Britain's Ground Crews Batter Germany's War Plants

MAINTENANCE

When the big bombers blast Nazi factories, credit the field men, the engineers, and the maintenance flyers. It's their work that makes possible the continuous pounding of Germany by heavy craft, such as the "Lancasters."



British Air Ministry Photo

Ground crew at work on an Avro *Lancaster*. This plane was developed from the Avro *Manchester*, largest twin-engine bomber in service with the British.

British Air Ministry Photo

Close-up of one of four Merlins used in the *Lancaster*. This newest of Britain's heavy bombers was first officially mentioned in the daylight raid on the Diesel works at Augsburg.

EVEN TO THE inexperienced eye the *Lancaster*, Britain's newest and fastest large four-engine bomber, looks good and *is* good. It is not only fast, but also extremely maneuverable, in spite of its size and weight. Fully loaded it weighs 60,000 lb. Its span is 102 ft., length 69½ ft., and it stands 20½ ft. high. The vast bomb bay can carry well over six tons of bombs, which is bad news for Germany's war factories.

In combat, the *Lancaster* can give a good account of itself. This was significantly proved by the reluctance of enemy fighters to engage *Lancaster* bomber formations of the RAF flying by daylight to Milan and Le Creusot. These long range daylight missions are without fighter escort. The trick of flying in tight formation, learned from American crews, helps solidify the defense.

Eight Thousand Rounds a Minute

Normally, a *Lancaster* carries three power-operated turrets, which can bring guns to bear on any target within a wide range in a matter of split seconds. These turrets give the *Lancaster* a total armament of eight 0.303 cal. Browning machine guns, firing over 8,000 rounds per minute. An additional power turret can be fitted to the underside of fuselage, bringing the total armament to ten machine guns.

(*Turn to page* 399)

British Air Ministry Photo

Patching and repair on one of the tail fins. Tail turret is in the middle, well to rear of these two widely spaced fins, giving excellent sweep for guns.

Armorers installing the four machine guns in tail turret.

REG. U. S. PAT. OFF.

KNURLING OF UNBRAKO SOCKET SCREWS

Gives You THESE EXCLUSIVE ADVANTAGES

KNURLED SOCKET HEAD CAP SCREW

KNURLING SAVES TIME AND LABOR

by preventing slipping, so the fingers can be used to best advantage. The firm grip enables mechanics to insert screws with speed and accuracy.

KNURLING PERMITS LOCKING

After countersinking, a few smart blows with a special locking-tool, having a circular edge and pilot in center, displaces enough metal to engage knurls and lock screw. Screw can be backed, out and used over and over.

Showing locked-in screw and locking tool.

SELF-LOCKING HOLLOW SET SCREW *with the Knurled Point*

Pat'd and Patents Pending

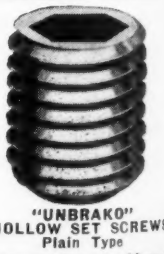
Knurled Point Locks Screw

The knurling is so cleverly done that —on the principle of a ratchet—the point makes no resistance when screw is *tightened*, but as soon as vibration tries to loosen it, the knurls "dig in" and positively prevent it. Screws can be removed with a wrench and used repeatedly.

Plus THESE ADVANTAGES

UNBELIEVABLE STRENGTH—"UNBRAKO" Screws register an ultimate tensile strength of 189,200 lbs. per sq. inch.
METAL SAVING—The great strength of "UNBRAKO" Screws permit the use of smaller and fewer screws. Because the key operates within the socket, "UNBRAKO" Screws can be used in the closest of quarters so designs can be more compact and lighter.
WEIGHT SAVING—The HEX SOCKET, mechanically indispensable, also helps to save weight—vital in aircraft design.
CLOSE TOLERANCE—"UNBRAKO" Screws are precision made.
DELIVERIES—better than average.
SIZES—from No. 4 to 1½" diameter.

"UNBRAKO" HOLLOW PIPE PLUGS
of Steel, Stainless Steel and Aluminum. Sizes ⅛" to 1" diam.



"UNBRAKO" HOLLOW SET SCREWS Plain Type
A favorite for over 30 years. Send for the "UNBRAKO" Catalog.

The knurling of Socket Screws originated with "Unbrako" years ago.

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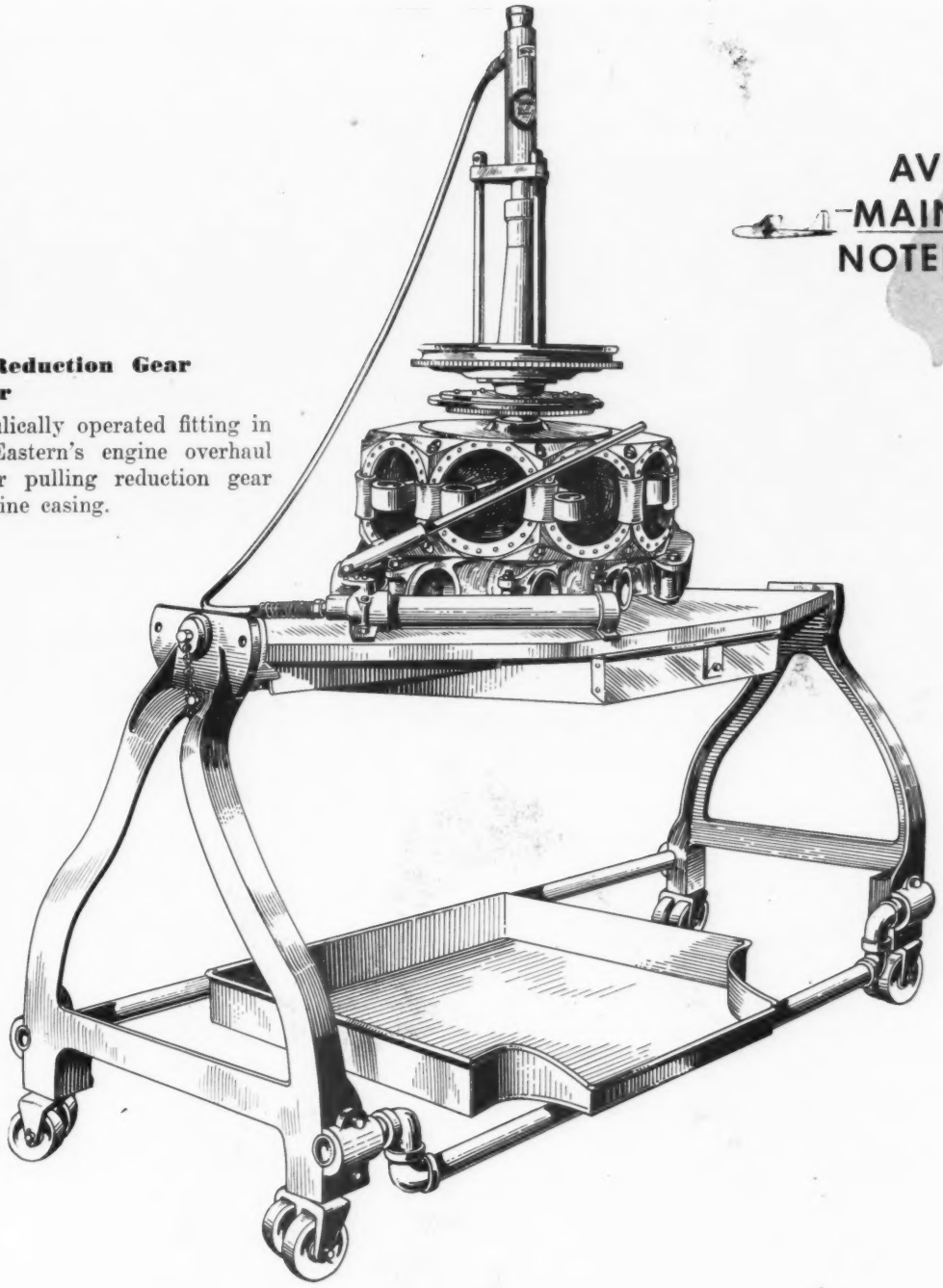
AVIATION'S MAINTENANCE NOTEBOOK

EAL's Reduction Gear Remover

• Hydraulically operated fitting in use at Eastern's engine overhaul shops for pulling reduction gear from engine casing.



Crankshaft Alignment Jig in American Shops

• Crankshaft bearers are standard, but this special installation design was worked out by Elmer Dougherty, of American Airlines. Micrometer gage, which gives readings to .0005 in. is attached to a brace which swings away from checking position to allow installation of crankshaft. Height adjustment is afforded by threaded collar on bearer. Clamp at right, with a similar one opposite, holds shaft for checking master rod bearing. All mounts are fastened to a heavy steel bed for permanent accurate position.

VICTORY'S MARGIN MAY BE FEMININE

Long since have we given up the idea that men alone can both fight and supply a global war. Clearly is this visible at Solar. Increasing numbers of women workers are assuming increasing importance in the production of "anti-monoxide" exhaust systems for the fighters, bombers and cargo airplanes of the United Nations. Well may it be said that on the production line, Victory's margin may be feminine.

ARMY E NAVY

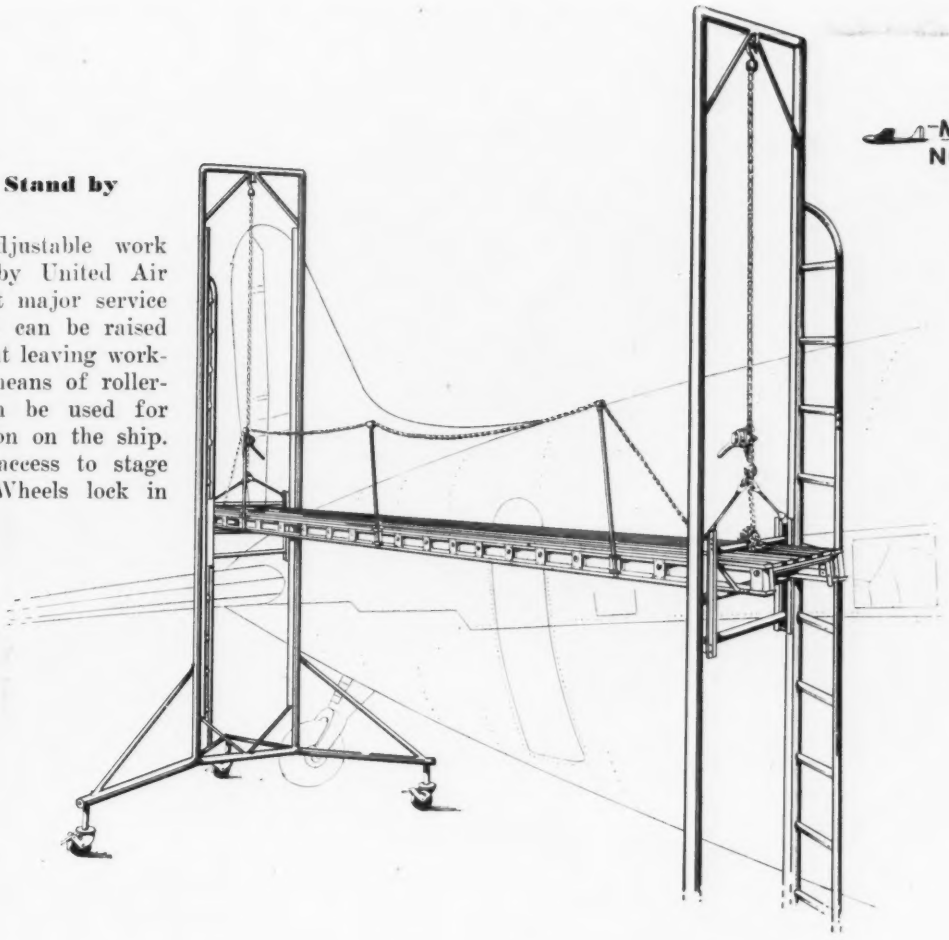
SOLAR

EXHAUST SYSTEMS—

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO, CALIFORNIA

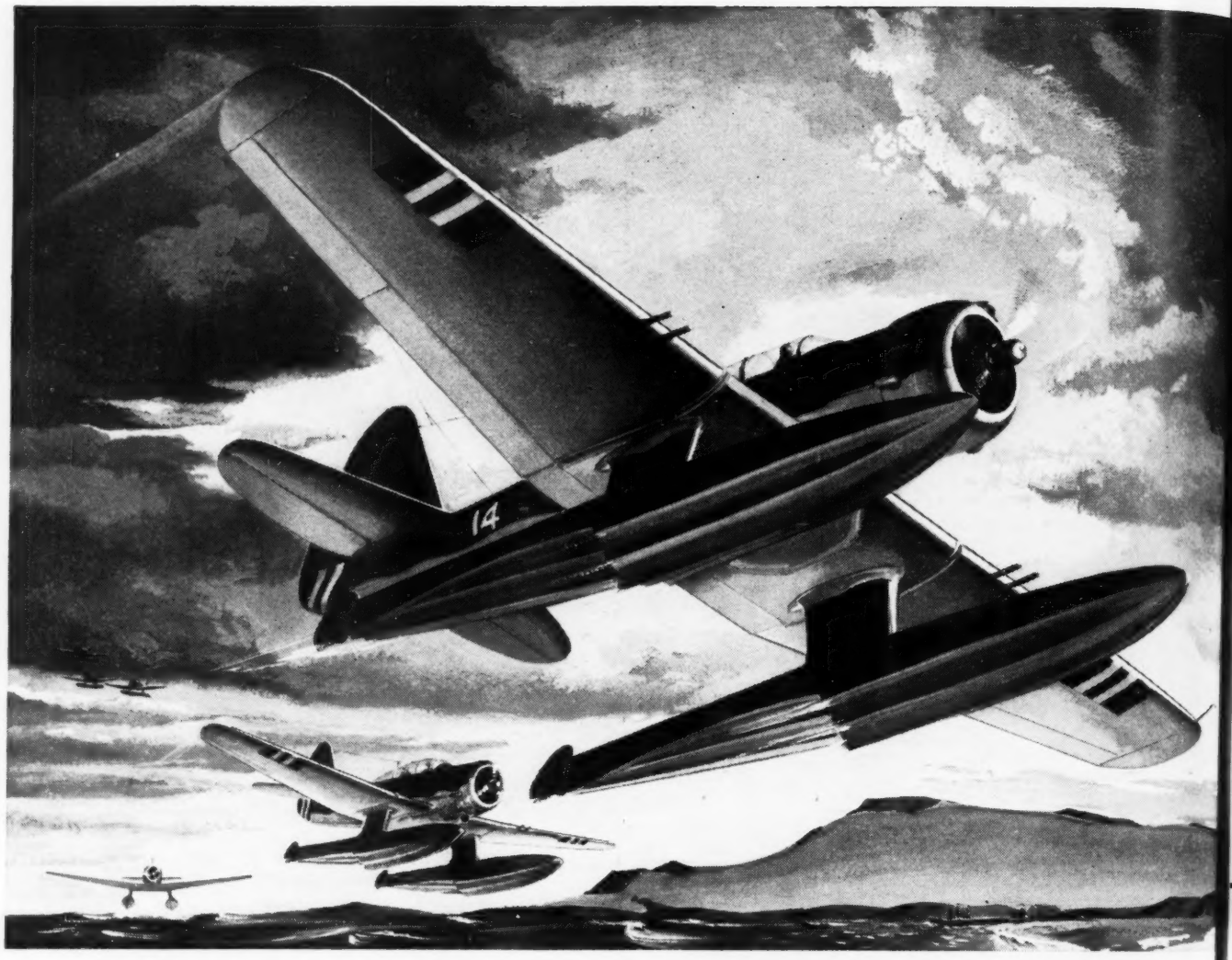
Elevator Work Stand by United

• All purpose adjustable work stand developed by United Air Lines and used at major service stations. Scaffold can be raised or lowered, without leaving working position, by means of roller-chain hoist. Can be used for nearly any position on the ship. Ladders provide access to stage at any height. Wheels lock in position.



Hydraulic Test Stand of American Airlines

• For testing all hydraulic assemblies and valves which can be removed from the ship, this American-designed unit incorporates a variable speed electric pressure pump of cam driven piston type which gives up to 2,000 psi. Assemblies requiring higher pressures can be attached to any of six outlets at right and be jacked by hand to 12,000 psi. Shock struts can be laid in racks, as at left, pumped up to required pressure and the lines shut off, leaving unit under pressure for any length of time, noting initial and final gage readings for check on extent and rate of leakage. On opposite side of stand is a similar rack for checking packing friction in operation of retracting, and other gear. With two lines for connecting at both ends of unit to be tested, piston can be run in and out, pressure readings giving resistance to motion. Too little requires tightening of packing, too much (more than 18 lb.) calls for loosening. Operator is testing a four-way valve.



Norway's unconquerable warbirds

These are the deadly Northrop N3 Patrol Bombers with which the Royal Norwegian Naval Air Force for nearly two years has helped to hold the Nazis on our North Atlantic sea border

BY MID-JUNE IN 1940, the Nazis had overrun all of Norway. And we here at Northrop had just begun work on a new patrol bomber for the Royal Norwegian Naval Air Force.

Quit? Not those fighting-hearted Norse! Teaming up with the RAF, they established "Little Norway" in Canada; ordered us to rush completion of these Northrop N3-PB's for combat use in the Far North.

The job, from preliminary sketches to the first bomber off the line, took us exactly nine months and one day.

We're particularly proud of that record, for the N3-PB is a favorite with Northrop men and women. Not just because this hard-hitting bomber is the world's fastest military seaplane. Nor because she can pack 2000 pounds of bombs or a torpedo with equal grace. Nor is it because she can throw more lead than many a four-motored bomber. What pleases us more than any of these virtues is her STURDINESS.

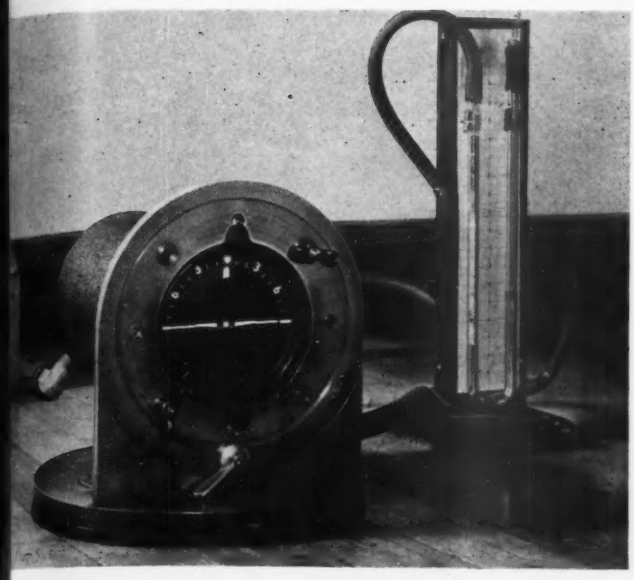
Battered for nearly two long years by North Atlantic winds and waves and storms, with vast distances their everyday assignment, these swift petrels of Norway's Royal Navy have proved as tough as the Vikings' sons who fly them.

In battle, the Northrop N3 Patrol Bombers have shown their strength too. They have sent to the bottom more than their share of U-boats. They are reputed to have taken part in the epic chase of the Bismarck. They have driven back giant German bombers.

We hope you'll pardon a manufacturer's pride in relating all this to you for the Northrop N3-PB is just one of a number of American-built warplanes that have helped to set the pattern for victory. *(You can help to shape the victory pattern more swiftly by buying War Bonds in increasing numbers.)*

NORTHROP AIRCRAFT, Inc.

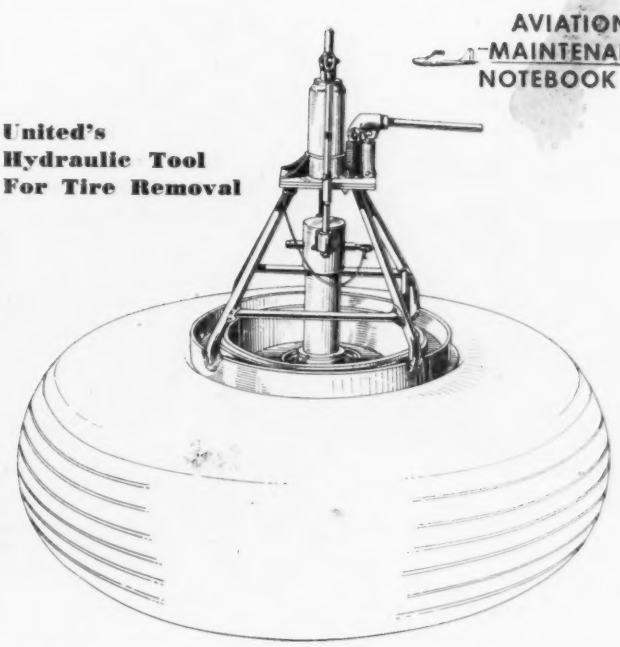
NORTHROP FIELD, HAWTHORNE, CALIFORNIA • MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.



Used by TWA
Artificial Horizon Calibration Fixture

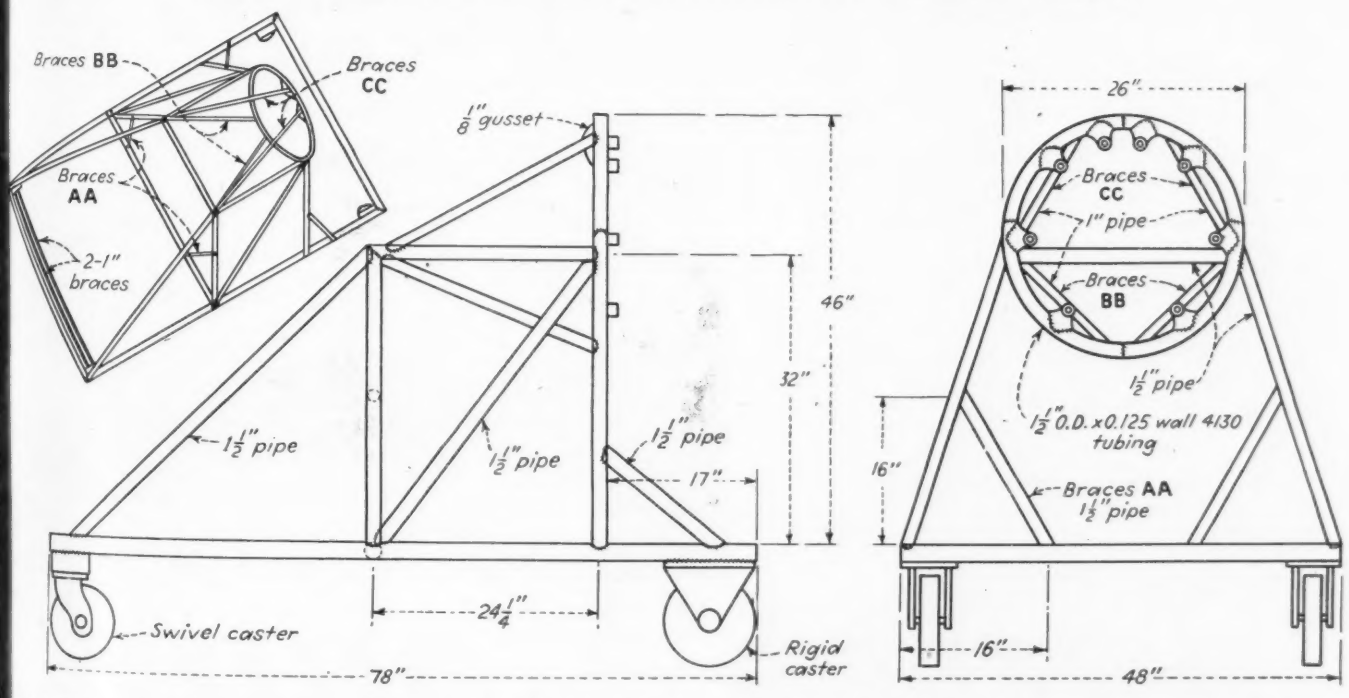
• Simplified swivel fixture enables calibrating mechanic to keep mechanism of artificial horizon fully under control at all times. This is very necessary while horizon is being upset for the purpose of checking bar settling times from the different displacements which are necessary. TWA personnel report this unit to be one of the most used fixtures in the overhaul shop.

United's
Hydraulic Tool
For Tire Removal



• Steel frame and hydraulic jack, which fits over axle and is secured by pin through bolt hole. Pressure applied by jack forces the frame down, separating tire from flange without damage to either. Developed from suggestion offered by Bill Pitt, United Air Lines mechanic, and in standard service in United system.

Chicago & Southern's Portable Engine Test Stand for Continental Engines



• Detailed drawings of portable engine test stand, designed by W. L. Anderson, Superintendent of Engineering at Chicago & Southern. This is the stand pictured in article titled, "Adapting Assembly Line Technique to Engine Overhaul," page 120, Dec. AVIATION. Overhauled engines are bolted directly to stand and wheeled to test cell, where they are locked in place for run in, saving time and handling. Location of mounting holes will be found in Continental Operating and Maintenance Manual of Model W670, series 6A & MA, p. 41, Fig. 15. Perspective drawing is not to scale, drawn merely to show position and inter-relation of braces not visible in dimensional sketches.

ARMY E NAVY

Awarded To Our Kansas City Plant

PRODUCING for WAR... PLANNING for PEACE

As a long-time user of Butler Built steel hangars, machine shops, warehouses and truck tank refueling units, the aviation industry is entitled to know why we are unable to fill orders—except on high priority ratings.

The explanation is in the composite picture above. It shows Butler Built steel products that are proving to be some of the most vital equipment of modern warfare.

Until steel runways are laid, until steel hangars, barracks, machine shops and warehouses are erected; until refueling tanks are on the battle fronts, our warplanes and mechanized fighting forces cannot bring to bear their unmatched force and fury. So it is that Butler metal crafters work around the clock to match the stride of the aircraft and mechanized armament industries.

As Butler produces for war, Butler engineers plan for peace. Better Butler Built steel buildings for the aviation industry post-war have already emerged. Witness the Butler Rigid Frame structure pictured at the right. Note the clear head room to the very peak of the gable.

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GALESBURG, ILL. MINNEAPOLIS, MINN.

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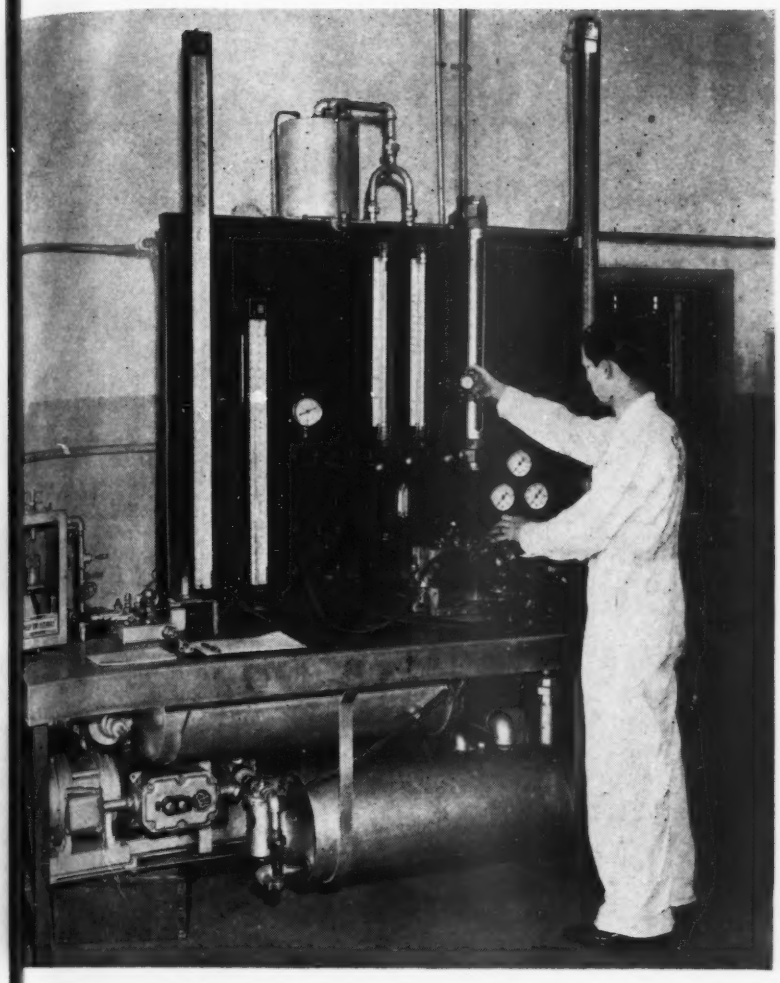
BUTLER BUILT

STEEL BUILDINGS

FOR SALE—SHARES IN TOMORROW—U. S. WAR SAVINGS BONDS

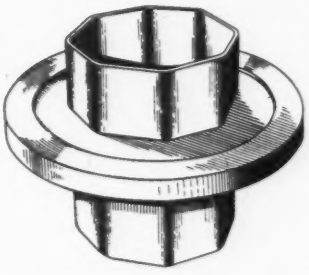


Chicago & Southern Carburetor Flow Test Bench

• For calibration and flow testing of Bendix-Stromberg injection carburetors, this unit is standard except for addition of small Fischer & Porter flow meter for testing idle adjustment setting. By setting all butterfly angles to an established standard for idling, then adjusting idle flow to an established standard, it has been found possible to adjust idle metering of carburetor prior to installation on engine, with very little trimming adjustment required on engine test. Another addition is a large Fischer & Porter flow meter as a double check against standard burette flow readings normally taken on this stand.

PAA's Propeller Retaining-Nut Wrench Attachment

• To counteract "bellying out" tendency of hexagonal gripping section of propeller retaining nut wrench, William Albritton, Chief of Pan American's N. Y. propeller shop has devised this ring which fits tightly over wrench "hex" section and rests snugly inside forward barrel shelf. It consists of two rings, the inner revolving freely within the outer on roller bearings, taken from an old thrust bearing. Inner part turns with wrench, gives firm centering support, prevents slipping.



TWA Bench Oscillator

• This pocket-sized oscillator was designed to relieve the large Sperry Scorsby oscillator for exclusive job of function-testing Gyropilot Control Units. It consists primarily of a mechanism which gyrates instruments about all three axes of motion in a gentle synchronous movement adjustable in three steps from 0 to 30 deg. of amplitude. Use of this oscillator during calibration results in better service performance of directional Gyro and Artificial Horizon Indicators. Power unit consists of motor driven gear reduction box mounted under calibration bench to conserve working space. Oscillator, when stopped in either right or left hand position, can be used for still test calibration in angles of 3, 7½, and 15 deg.

"THUNDERBOLTS"... Across the field and out of sight in a matter of seconds, *Republic P-47* squadrons, in thunderous flight, streak to battle. Such speed and power mark a new epoch in high-altitude fighter combat . . . portend the final purge from the skies of the emblems of piracy.

REPUBLIC AVIATION

REPUBLIC AVIATION CORPORATION — REPUBLIC AVIATION — FARMINGDALE, L. I., NEW YORK

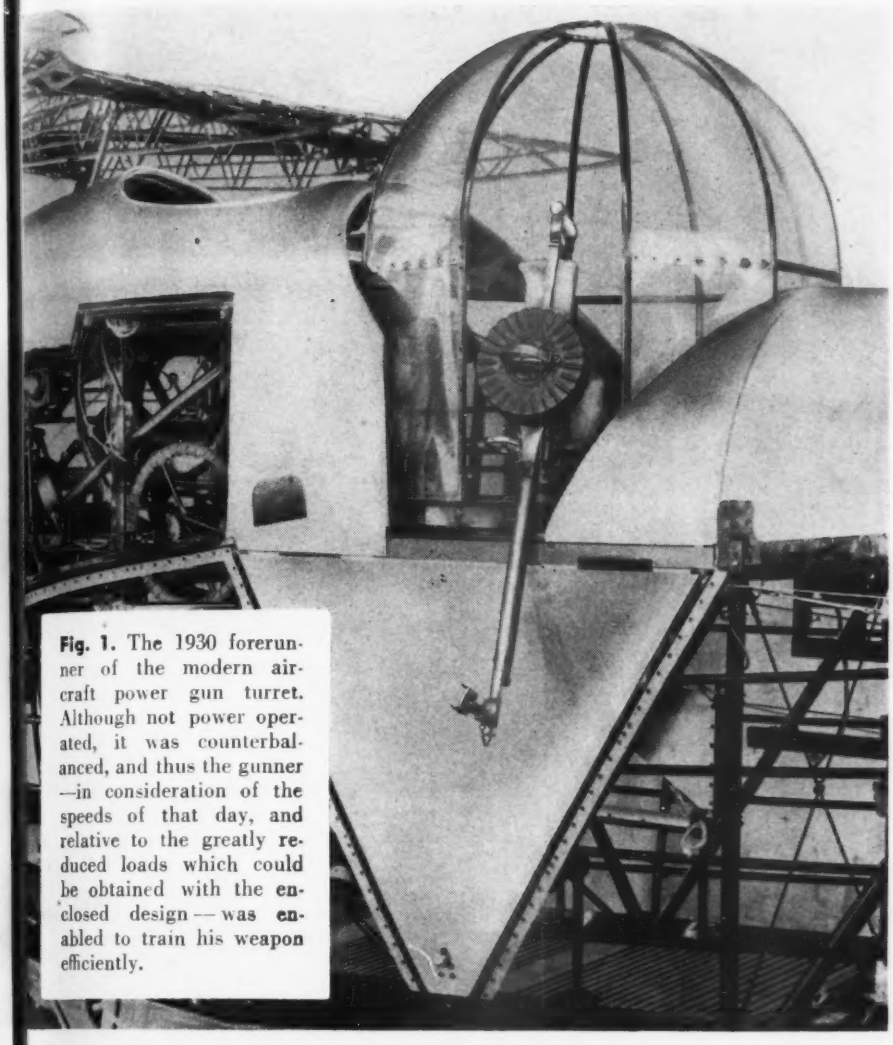


Fig. 1. The 1930 forerunner of the modern aircraft power gun turret. Although not power operated, it was counterbalanced, and thus the gunner —in consideration of the speeds of that day, and relative to the greatly reduced loads which could be obtained with the enclosed design — was enabled to train his weapon efficiently.

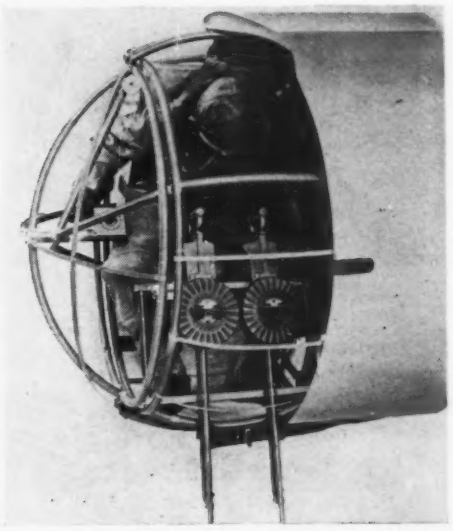


Fig. 2. Second step in gun turret development, in 1933, gave gunner a geared hand control over both elevation and traverse. Here, gunner moved with his guns, had advantage of sighting through the same screen panel.

Designing Gun Turrets As Integral Part of Aircraft

By L. G. FRISE,
Chief Engineer to Aircraft and Armament Divisions, Bristol Aeroplane Co.

Development from hand-operated to hydraulic-powered multi-gun units is traced by sketches and photographs which reveal design and construction details of Bristol turrets.

OUTSTANDING POSITION held today by Bristol power-operated gun turrets is due largely to the fact that these units have from the first, been designed by the men who created the aircraft in which they have been proved. The benefits of this method—over the alternative of trying to standardize a turret without control over the design of the aircraft to receive it—have to be experienced to be appreciated.

The many military aircraft types developed by the Bristol Co., have entailed consideration of practically all forms of offensive and defensive armament. Thus it is perhaps most convenient to date our conception of the modern power-operated multi-gun turret from the first attempts, back in 1930, to enclose the gunner and gun, thus removing him from the slipstream.

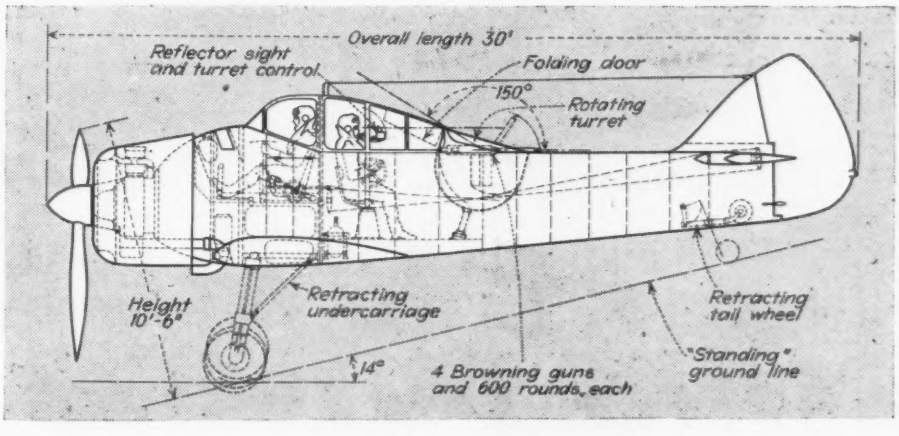


Fig. 3. First remotely controlled gun operation where gunner did not occupy the turret proper—a hand-operated gun built into a two place fighter.

FIGHT!!

with ELECTRICAL SPLIT-SECOND ACCURACY

NATIONAL'S PRECISION BOMB RACKS AND SHACKLES

LIGHT WEIGHT • LOW CURRENT DRAIN

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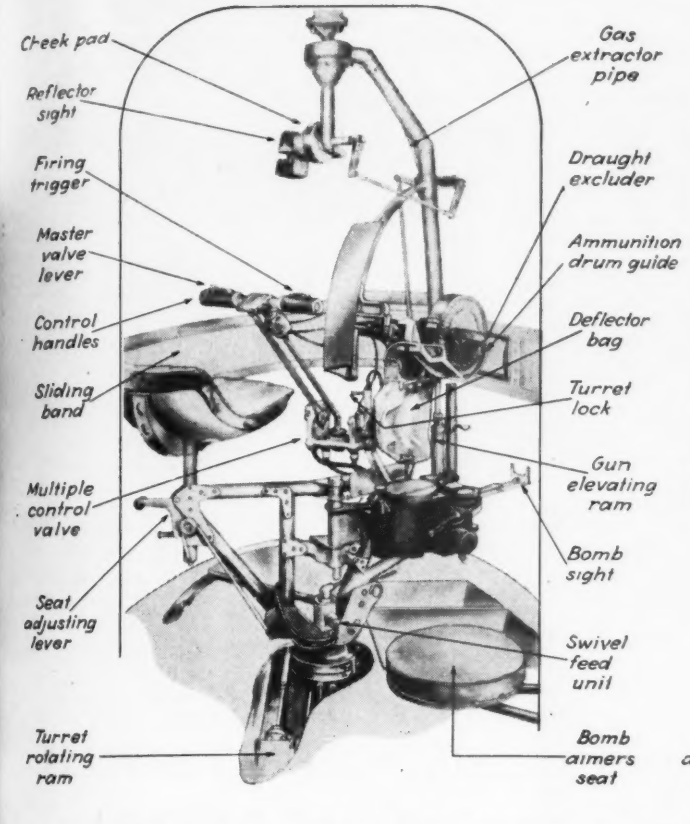
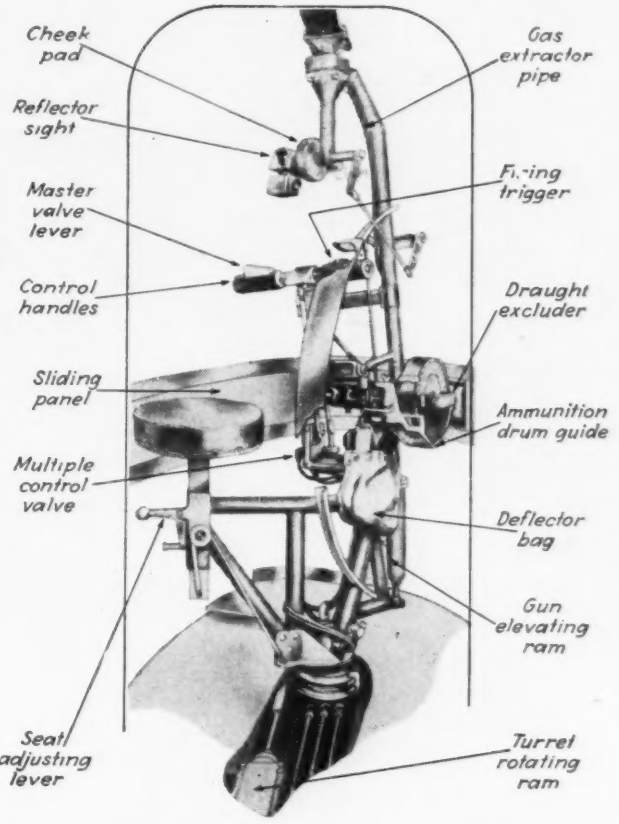




Figs. 4 and 5. Early hydraulic-operated nose and tail gun turrets. These units replaced electric drives designed for a 1932 bomber (which was ultimately developed into the Bristol *Bombay*). Most successful of the electric drives consisted of motor driving a disk from which variable speed and reversing friction drives conveyed motion to guns. Control was via small "joystick," but failure to get adequate smoothness caused shelving of electric systems until recently, when they again began to be used in a field dominated by hydraulic units.

Fig. 6. This 1934 development was for semi-open cockpits of Army cooperation planes, where performance of many observer's duties required gun mount of minimum obstruction. Featuring a powered-pillar mounting, its hydraulic follow-up system gave adequate and sensitive gun movement control with almost no increase in bulkiness over earlier hand-operated pivot types.

Fig. 7. First special mid-ship turret, a 1935 design for the original Bristol *Blenheim*, which was initial high-speed medium bomber to go into large scale production. Carrying one gun, this turret gave partial rotation in rear hemisphere only.

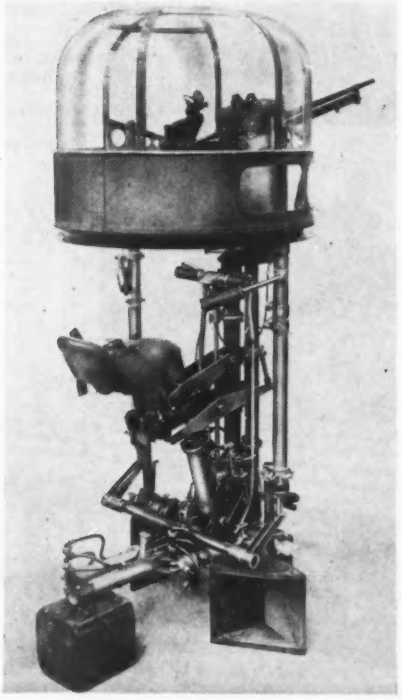
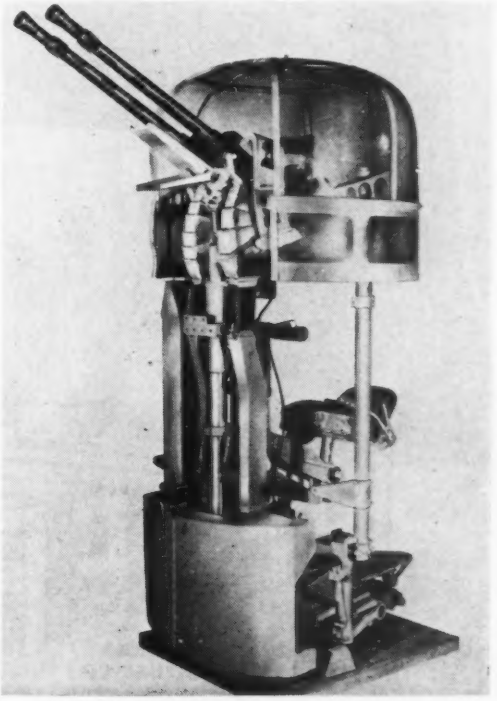
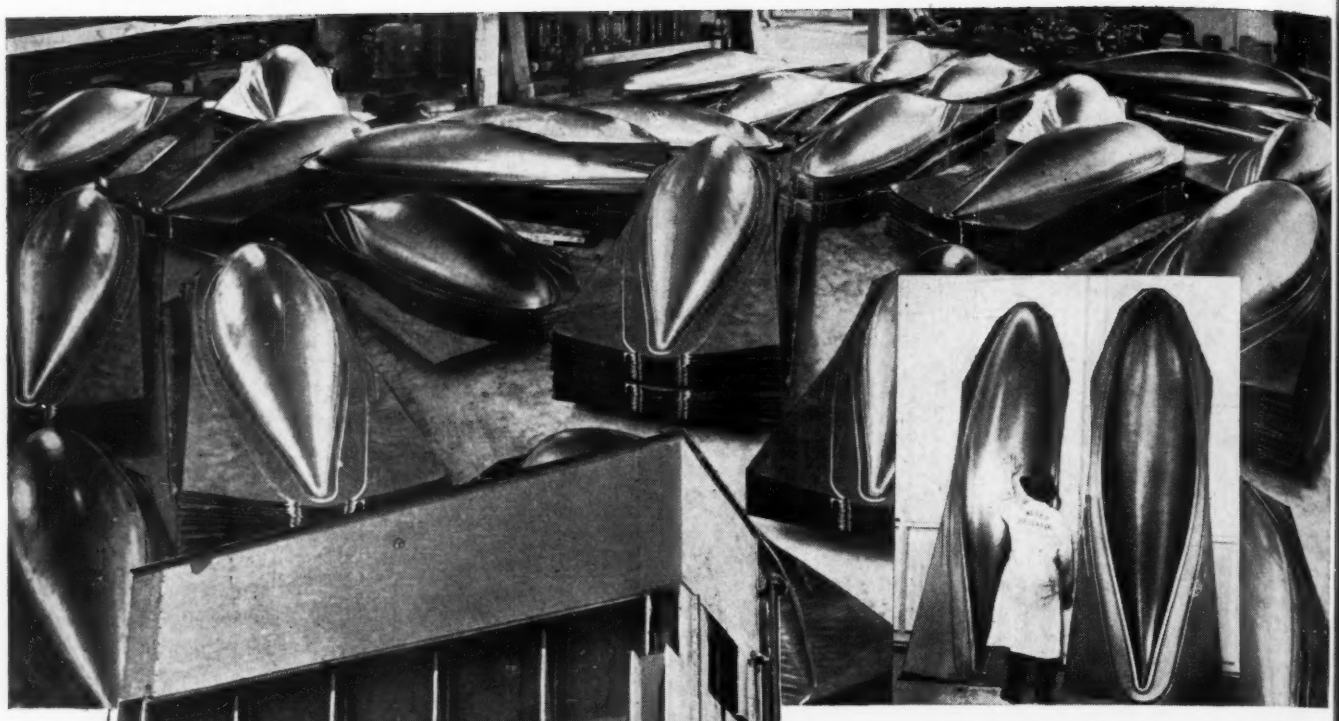


Fig. 8. Development of succeeding *Blenheim* turrets, such as that shown here, can be traced from system shown in Fig. 7 through types with different makes, numbers, and calibre of guns; varying ammunition feeds; sights and armor protection; and designs affording partial and complete rotation.





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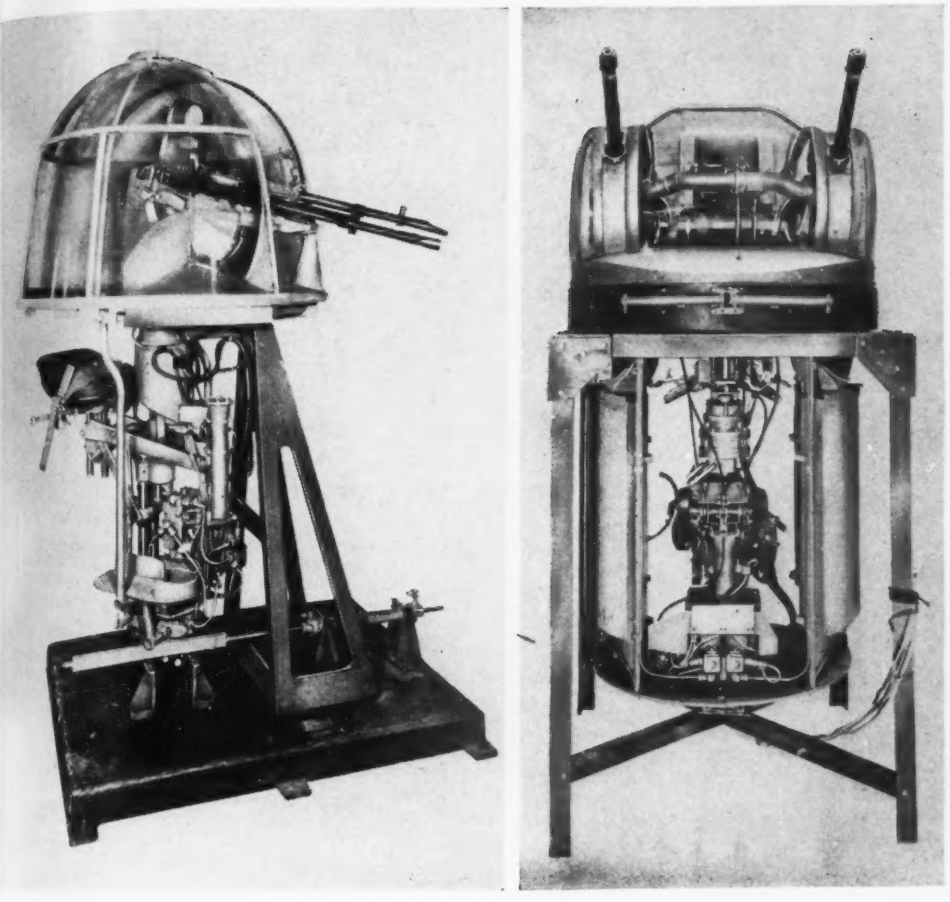


Figs. 9 and 10. Twin gun turrets developed for Bristol *Beaufort* and *Blenheim* medium bombers. Common feature of these two, and that shown in Fig. 8, is that gunner can remain in turret and still operate radio or other equipment in the aircraft located just outside periphery of turret. For this purpose, back of turret has been designed open and free from structure so that gunner has free access with his hands, a feature of special value where economy of crew is desirable.

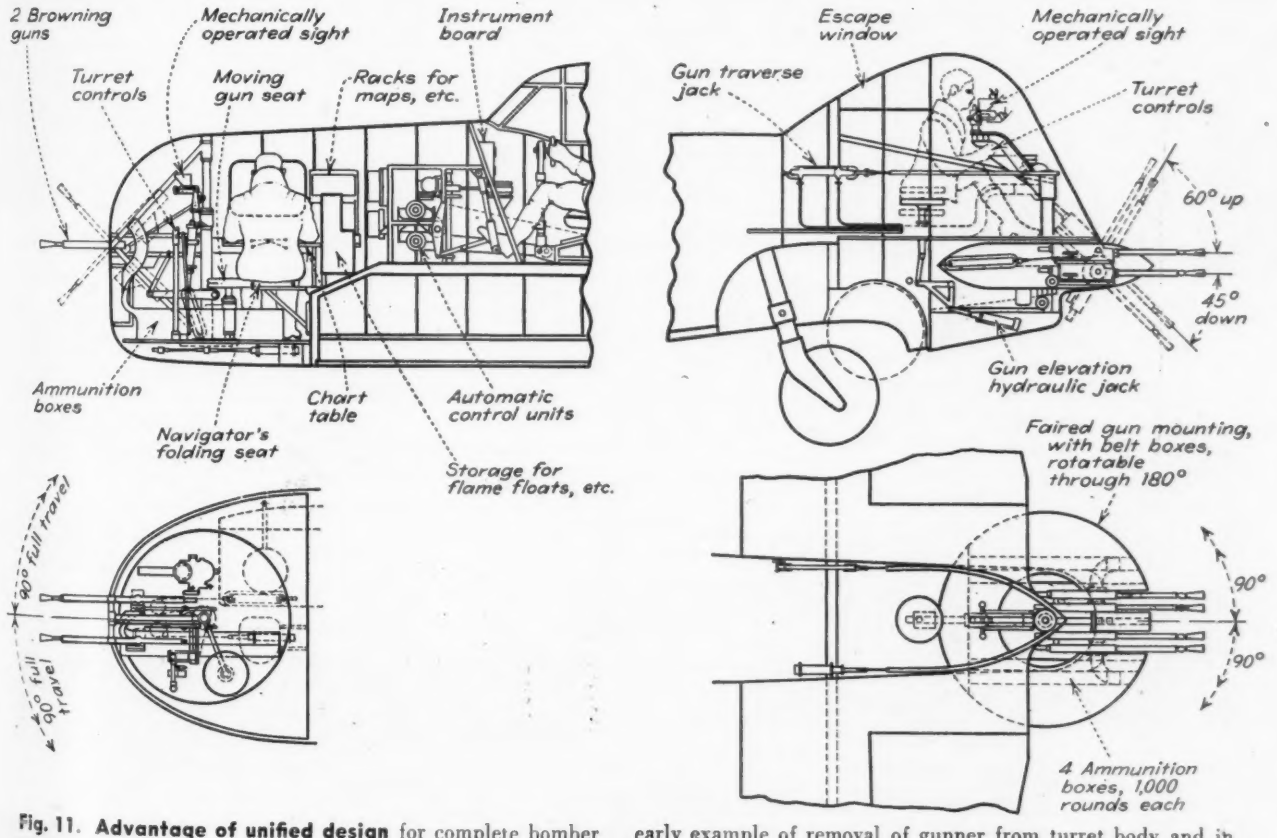


Fig. 11. Advantage of unified design for complete bomber and armament is shown here in arrangement devised to offer greatest possible performance without sacrifice of efficiency or effectiveness in armament carried. This turret, developed in 1936, shows how aircraft and turret structures can be smoothly welded into efficient combination. It is also an early example of removal of gunner from turret body and in addition shows size reduction which can be effected when gunner merely needs to move his head to follow sight. Interesting detail of this layout was complete absence of backlash obtained by operation in one direction only against a spring return.

Cuno Filters Have Flown 6,600,000 Transatlantic Miles Since May, 1939 . . . on Pan American Clippers

Northward to Foynes, eastward to Lisbon, southward to Leopoldville . . . Pan American clippers have carried 44,000 passengers and 2,500,000 pounds of mail on 1225 transatlantic flights since May, 1939. On every clipper, Cuno filters have been continuously on guard against foreign particles in engine lubricating oil, as well as on glycol heating systems.

Pan American Points the Way to New Era in Long-Range Aviation—and Ever More Efficient Maintenance Methods

You find continuously-cleanable Cuno filters on these trail-blazers of our air-borne merchant fleets because Cuno engineers — right from the beginning — worked with Pan American and other aircraft and air-line engineers to develop safe, sure fluid-cleaning for engine and supercharger lubricating systems, for hydraulic control and glycol heating systems.

Pan American *knows* their Cuno-protected fluids will be clean. The all-metal filter discs provide a *positive* method of removing from the fluid all solids of a size larger than specified. The filter element is permanent, eliminating need of frequent replacement — and non-collapsible, eliminating possibility of sudden breakdown in flight. It is lightweight and compact, yet handles full flow.

The filter itself is cleanable without interrupting fluid flow. A turn of the handle rotates filter discs past stationary cleaner blades which comb out imbedded as well as adherent solids. Where hand operation is impractical, a Cuno-developed hydraulic motor continuously cleans the filter. Occasional inspection and removal of sludge from the sump are all the attention a Cuno filter needs.

Pan American uses the hydraulic motor on engine lube systems, and manually operated filters on glycol heating systems.

First in the Aircraft Industry — Cuno Filters Used by Majority of Aircraft and Engine Makers

Today's widespread acceptance of Cuno filters in aircraft applications has naturally created a service responsibility. Cuno has accepted this responsibility by establishing a competent maintenance and advisory staff which works closely with service departments, making sure that operating crews become thoroughly familiar with Cuno trouble-free fluid protection and low-cost maintenance.

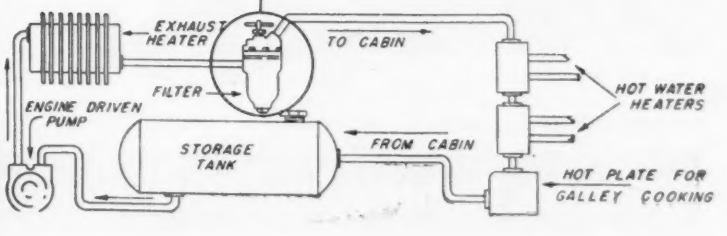
Send for FREE Booklet "QUICK FACTS"

Cuno Engineering Corporation, 704 South Vine St., Meriden, Conn.

HELPS DETECT ENGINE TROUBLE

This Pan American mechanic holds the head and cartridge assembly of a Cuno Auto-Klean used to filter glycol in heating appliances (see diagram below). On the table is also one of the four self-cleaning engine oil filters built in as standard equipment on the Wright Cyclones which power the big clippers. Pan American maintenance men carefully inspect sludge removed from Cuno filters for signs of engine wear. If the mechanic finds metal particles, this automatic warning of engine wear permits repairs to be made before major trouble develops. Pan American finds this a highly useful additional feature of the filter that "safeguards the fluids that safeguard flight".

Glycol heating system on Boeing Clipper used by Pan American Airways System



KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

Maker of Air History—

The Boeing Flying Fortress

Assembling a harness for the B-17 in the Boeing plant. Belden wire is used.

Approximately five miles of wire are used in a Flying Fortress. Every connection is inspected by experienced examiners.

ANOTHER PLACE
WHERE BELDEN WIRE GOES TO WAR

A familiar figure on battle fronts from the Bering Sea to the Mediterranean or the South Pacific, the Boeing Flying Fortress has provided a perfect platform for wonderfully accurate, high altitude precision bombing. Since Pearl Harbor, the famous B-17 has constantly made the "news" with amazing feats of stamina and heroism.

With production more than quadrupled—and an ever increasing demand for more—Boeing Aircraft Company has maintained in all detail its high standards for workmanship and materials. And, here along with thousands of other service-tested parts, Belden wire goes to war.

Back of Belden aircraft wire is a lifetime of experimenting and testing—collaboration with aircraft engineers since flying was in its infancy. This vast experience makes possible the Belden wire that meets today's needs.

Belden Manufacturing Co., 4665 W. Van Buren St., Chicago, Ill.

Awarded the U. S. Treasury Special Citation of Merit for initiating the War Bond-or-Cash Dividend Plan

Belden *Aircraft* WIRE

Starter, Lighting, and Instrument Cables √ √ √ SPARK PLUG WIRES

Messerschmitt Me-210A-1

Latest Nazi fighter-bomber features remote-controlled "blister" guns for rearward protection, also new type dive brakes.

EVIDENCE that Germany's Luftwaffe is attempting to catch up with the United Nations in the field of power-operated gun turrets is given in reports on the Messerschmitt Me-210A-1, long range fighter-bomber.

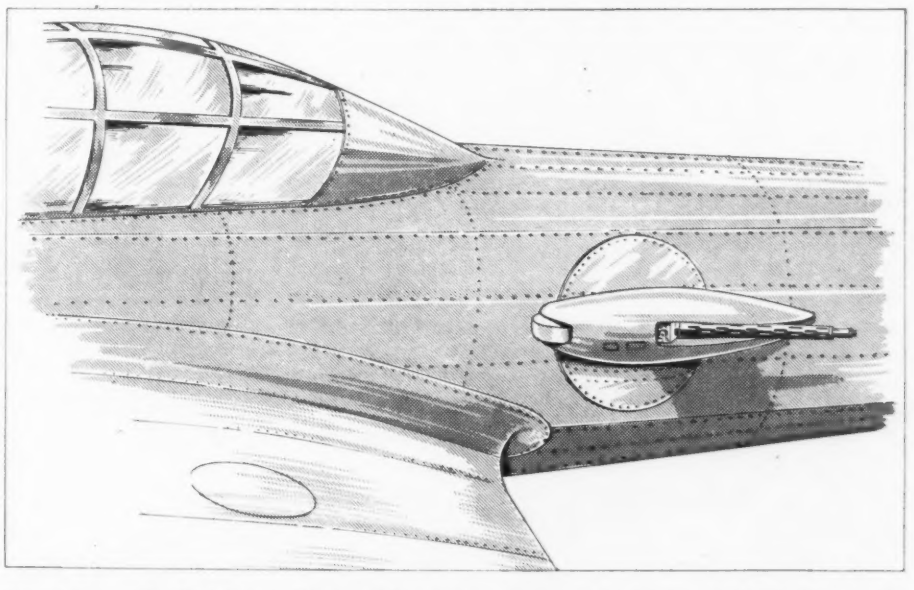
Developed from the Me-110, the new craft carries a crew of two, a pilot-bombardier and a radio operator-rear gunner, and it is designed for use as a long-range fighter, dive bomber or ground attack craft. Defensive armor plating—with a total weight of approximately 900 lb.—is provided for both crew and vital parts of the plane. Armament consists of two 20-mm. Mauser cannon and two 7.9-mm. machine guns, fixed in the nose, and two 13-mm. machine guns firing to the rear in remote-controlled "blisters".

This latter installation is perhaps the most interesting on the plane. The rear gunner, facing backwards, is seated just behind the pilot under the same cockpit cover, above and ahead of the guns. Aiming through reflector sights, he controls the guns through a pistol-like control grip.

Both guns are mounted in streamlined blisters in the end of a drum which runs through the fuselage just aft of the trailing edge of the wing. Movement of the pistol-grip engages friction bands with either of two small drums—revolving in opposite directions from power delivered by a 1½-hp. electric motor—to elevate or depress the guns. Movement of the small drums is transmitted through a pinion engaging a gear which surrounds the gun drum. A maximum swing of 70 deg. can be accomplished; 35 deg. above horizontal and 35 below. Lateral movement of the guns is given by a similar friction band unit, except that in this case a gear surrounding the drum is attached to a gear which, in turn, drives a pinion to impart the motion. The guns can be synchronized but 2 deg. off center, but they can be swung independently, however, to a maximum of 35 deg. toward the side.

British Combine

Among latest German planes is Messerschmitt Me-210A-1, long range fighter-bomber developed from well known Me-110. Outstanding feature is Nazi attempt to catch up with United Nations designers in use of power-operated gun turrets, details of which are shown in accompanying sketch.



Remotely controlled by radio operator-rear gunner, who sits just behind pilot facing to rear, are guns on each side of fuselage set in streamlined blisters. Mounting is electrically-rotated drum running through fuselage to give maximum of 35-deg. elevation and same depression for 13-mm. machine guns. Lateral motion, also limited to 35 deg. to the side, is given by similar unit operating within drum.

Specifications and Performance Data

Span	53 ft. 9 in.
Length	40 ft. 3 in.
Gross weight, approx.	21,300 lb.
Bomb load (max.)	2,200 lb.
Fuel capacity	550 gal.
Maximum speed (est.)	385 mph.
Engines	Two Mercedes-Benz DB-601F-1
Armament	Two 7.9-mm. machine guns and two 20-mm. Mauser cannon, fixed in nose; two 13-mm. machine guns in remote-controlled blisters.

BANISH GHOSTS
WITH THIS NEW TRACING CLOTH

PHOENIX is the new kind of tracing cloth, proofed against perspiration stains and water marks —*that holds erasure scars at a minimum.* PHOENIX gives you clean tracings, in pencil or ink, free from untidy "ghosts" that reproduce on blueprints!

An exclusive new process is responsible for this amazing performance, a process which defies moisture, and gives PHOENIX its unusually durable working surface. You use harder pencils... get sharper lines with less tendency to smudge. Even 6H pencil lines show clearly, and reproduce strongly. You don't mar the surface when you erase; erased areas take pencil smoothly —and ink without feathering. Its new white color and its increased transparency provide excellent drawing contrast... produce strong blueprints.

Give PHOENIX your own drawing board test. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

PHOENIX DEFIES MOISTURE GHOSTS

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*

PHOENIX LESSENS SMUDGE GHOSTS

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.

PHOENIX REDUCES ERASURE GHOSTS

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

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for pencil *and* ink

EST. 1867
KEUFFEL & ESSER CO.
NEW YORK · HOBOKEN, N. J.
CHICAGO · ST. LOUIS · SAN FRANCISCO · LOS ANGELES · DETROIT · MONTREAL

As is the case in the Me-110, the fixed machine guns and cannon mounted in the nose are equipped with flash tubes (see page 98, Nov. AVIATION), which aid in cooling.

A new "wrinkle" in dive brakes for both upper and lower wing surfaces has been developed on this new Messerschmitt product. Mounted just behind the single spar, the brakes consist of hydraulically operated parallel perforated L-shaped aluminum alloy slats, the brake for the top surface having three such slats, the lower, four. In retracted position, the brakes fit flush with the wing surfaces to eliminate drag for normal flight.

The 210A-1 is equipped with two Mercedes-Benz DB-601F-1 engines. These appear to differ from the DB-601E used in the Me-109F fighter only through addition of special ducts which direct a stream of cool air to the spark plug wells and exhaust stacks, the latter probably being an attempt at flame damping.

The plane follows conventional construction practice, the wings having metal spar, ribs and flush-riveted metal covering, and fabric-covered ailerons. Fin and stabilizer are both metal, but rudder and elevators are fabric covered.

SIKORSKY HELICOPTER PASSES ARMY TESTS

Army-Sikorsky helicopter which, following Wright Field tests, resulted in award of production order to Vought-Sikorsky division of United Aircraft Corp. Closed model is of welded tubular construction. Main rotor has diameter of approximately 36 ft., vertical rotor at tail 7½ ft. Over-all length of craft is approximately 38 ft., height 12 ft., and gross weight 2,400 lb. Power is furnished by 7-cylinder Warner engine by gear and shaft transmission to the two rotors. Craft can be equipped with low pressure floats to operate from land, water, snow, marsh, or thin ice.

Bird-Proof Windshield

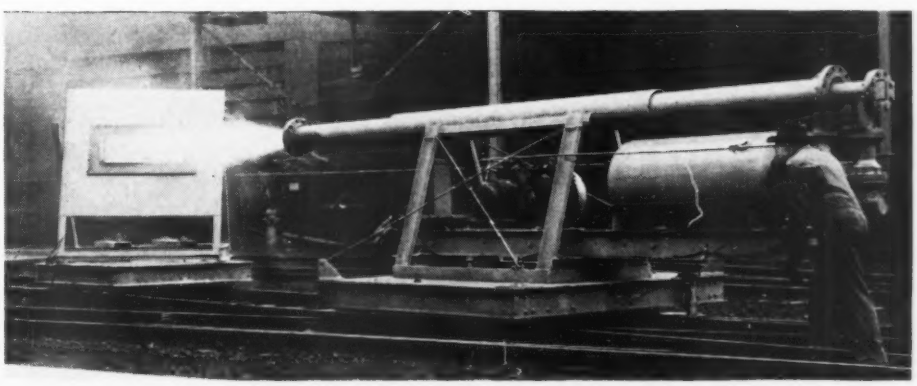
Protection of pilots against injury or even death resulting from collisions with flying birds, together with satisfactory de-icing, appears imminent following recent cooperative experiments. Numerous injuries have resulted from ducks, wild geese, seagulls and other birds crashing through windshields, especially at night. In at least one instance, a bird went through the windshield, the bulkhead, on through the length of the cabin, and on into the baggage compartment.

The research to date has produced a plastic and glass shield which will withstand the impact of a 15-lb. bird travelling at speeds above 200 mph. The experiments were directed by John Easton, chief of the Civil Aeronautics Administration's Technical Development Division, and A. L. Morse, chief of the Aircraft Development Section of that Division. Cooperating were technicians of Westinghouse Electric & Mfg. Co., E. I. du Pont de Nemours, Monsanto Chemical Co., Pittsburgh Plate Glass Co., and Libbey-Owens-Ford Glass Co.

Westinghouse developed a special compressed air gun with an 8-in. bore and 20-ft. barrel into which freshly killed fowl are placed, inside flour sacks, and shot against test windshields at speeds simulating actual flight conditions. Velocities in excess of 400 mph. can be attained.

One promising type of panel developed is made by laminating a ½-in. sheet of especially prepared polyvinyl acetal resin between two panes of semi-tempered glass, each ⅛-in. thick. The amount of plasticiser used is adjusted to provide maximum toughness and resiliency at flight temperatures. The ½-in. plastic sheet extends about an inch beyond the glass and is bolted to the reinforced metal frame of the aircraft. To prevent the windshield tearing loose from the frame, sheet metal strips are embedded in these extended edges.

The complete windshield assembly includes a front pane of ¼-in. tempered glass, separated from the impact resistant panel by a narrow air space through which hot air can be circulated to serve as a de-icer.



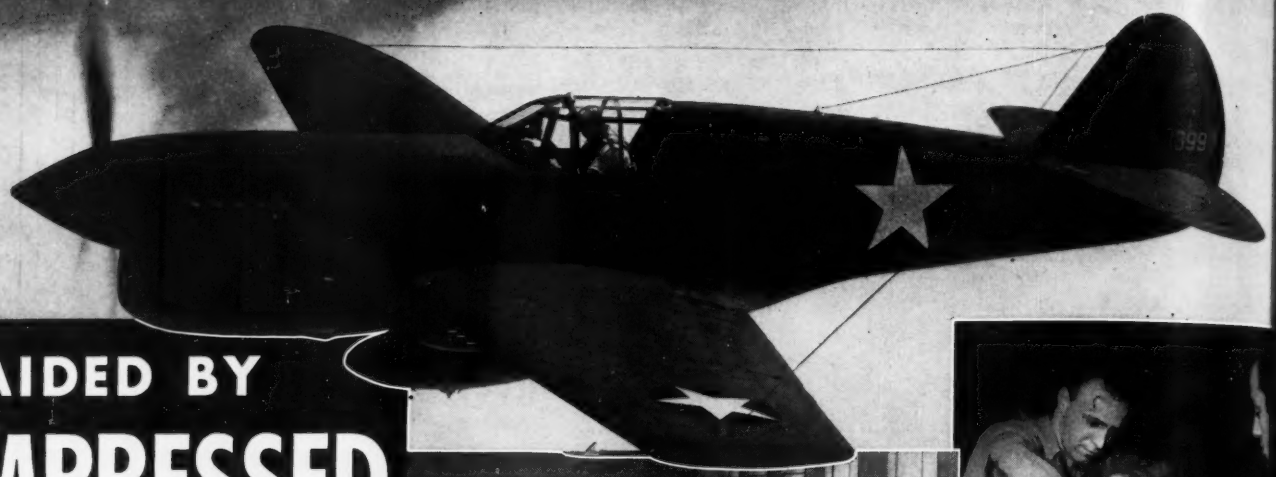
FOR SAFER FLIGHT

Compressed-air gun shoots freshly-killed birds against windshield under simulated flight conditions in cooperative government-industry research program to eliminate injuries due to collision between planes and birds in flight. Plastic and glass manufacturers, working with CAA, have developed windshield which will withstand impact of 15-lb. bird at speeds over 200 mph.

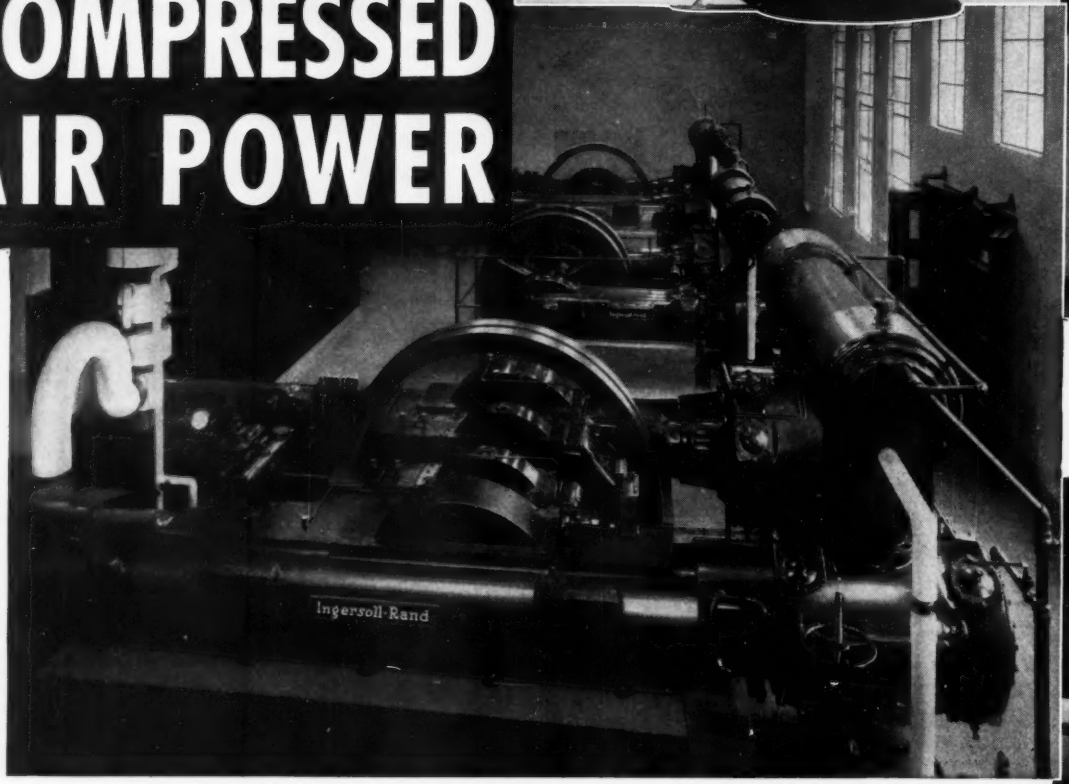
Ryan To Build New Navy Combat Plane

Ryan Aeronautical Co. is revising its production program to take on design of a new combat craft for the Navy, T. Claude Ryan, president, has announced.

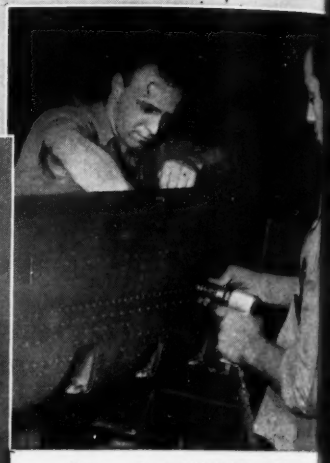
WARHAWK Production



AIDED BY COMPRESSED AIR POWER



2150 hp of Ingersoll-Rand steam- and electric-driven compressors at a Curtiss-Wright plant.



Above — Curtiss-Wright workers sinking flush rivets with a 3-lb Size AVC-10 Ingersoll-Rand riveter.

Below — Lightweight Size-OOK drills with angle attachments help fabricate Warhawks.

Below—Flush riveting with an AV-13 riveter on a Warhawk pannel.

Curtiss-Wright is producing a steady stream of those swift and maneuverable P-40F Warhawk fighter planes that deal deadly blows to the enemy.

Compressed air plays an essential part in the production of these planes. Its use is essential in the mines that produce aluminum, copper, iron, zinc, tin, lead, chromium, and other vital metals. No forge shop, machine shop, or fabricating and assembly line could get along without it. At the flying fields compressed air inflates the tires, charges the landing-gear shock struts, and helps in many ways to keep the planes ready for action.

Tools operated by compressed air are light in weight, easily handled, quickly adapted to many kinds of work, extremely durable, and economical to operate and maintain. Many jobs cannot be done as well, or even at all, with any other form of power. The building of compressed air machinery—all kinds of compressors and the tools that use the air — has long been Ingersoll-Rand's job in war and peacetime.

1-235

• • • • All plants of the Ingersoll-Rand Company are flying the Army-Navy "E" awarded for "high achievement in the production of war materials."

Ingersoll-Rand

11 Broadway • New York, N.Y.

OTHER I-R PRODUCTS: ROCK DRILLS, PUMPS, CONDENSERS, STEAM SHOVELS, DIESEL & GAS ENGINES, HOISTS, PNEUMATIC TOOLS

Cleveland Courier Service Gets Industry Backing

CAP Courier Service, which got a real start in New York last summer (AVIATION, Aug., p. 215), carries increasing loads for war. Cleveland unit, established Dec. 1 on underwriting of about $7,000 from approximately 50 manufacturers, now has duration assignment from their owners of 20 planes—65-hp. Pipers, Aeroncas, Taylorcrafts, and Ercoupes to 215-hp. Wacos, Stinsons, and Fairchilds. Under direction of CAP Lt. Dean H. Robinson, station commander (right), and with symbolic inspiration of cavern-mouthed bird, 50 pilots from Ohio Wing groups 511 and 514, 12 of them with more than 1,000 hr. experience in air, are rushing materials and personnel from Cleveland war plants to places off beaten air trails.

One urgent request came from Picker X-ray Corp., where A. E. Fingerhut (left) foreman of the electrical department, found that 50 Army field X-ray machines were being held up for lack of meters. James Dunn, company purchasing agent (right), phoned details of difficulty to Courier Service office provided by Cleveland Chamber of Commerce.

A plane was dispatched to Bluffton, Ohio, and brought needed meters back to Cleveland where a Picker man sped them to factory. Two days were saved, and X-ray machines made convoy. Meanwhile, Mrs. Dorothy Forkel, whose year's flying experience of 126 hr. was been gained mostly with CAP, kept Curtiss-Wright production lines moving by flying 50 lb. of parts into Buffalo courier station, now manned by 20 pilots and 12 planes.

CIVIL OPERATION AND TRAINING

Women Instructors Graduated

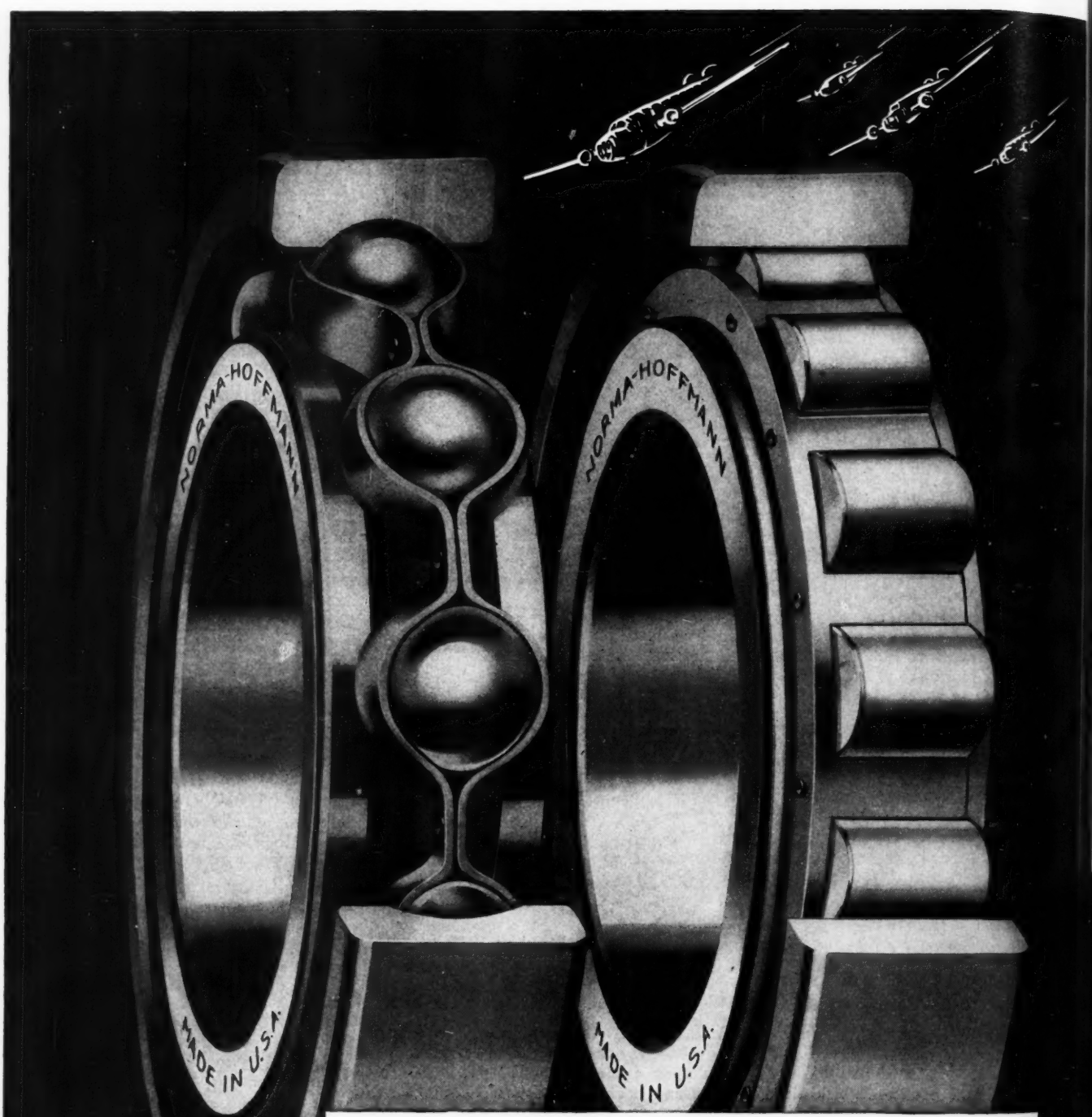
First ten of what the state hopes will be hundreds of women flight teachers have been graduated from the Women's Instructor Training School conducted at Nashville by the Tennessee Bureau of Aeronautics.

So great was the demand for their services after 15 weeks' learning under the direction of Phoebe Omlie, on leave from CAA, that the state is urging the Senate Appropriations Committee to provide $2,500,000 for the graduation of 500 more women instructors in other parts of the country during the next six months, with 400 others in training. Tennessee alone has received 1,000 requests for such instruction.

Each of the new teachers offered approximately 120 hr. flying experience when accepted for the course. One was a practicing aeronautical engineer, another the wife of a CAA instructor and a member of CAP. During training these women brought their hours in the air up to a minimum of 165, qualifying for a commercial pilot's certificate, the rating of flight instructor, and additional ratings for completing courses in meteorology, navigation, aircraft structures, engines, and civil air regulations.

Bids for their services were received from school boards and flight instruction contractors throughout the South. One Florida contractor offered jobs to the whole class. At present, however, the graduates are scattered from New Mexico to Missouri.

Funds for conducting the flight instructor courses were derived from the Tennessee tax on aviation gasoline. Of the seven cents collected on every gallon, half is retained by the selling airport and the remainder forwarded to the Bureau of Aeronautics. This money has thus helped sustain airports and enabled the bureau to install state-wide air markers, conduct aviation education projects in every county, print textbooks, and give a course in airport management at the University of Tennessee. Present income of $200,000 a year is being spent on further improvements in flying facilities and introduc-



PLEDGED to all-out aid to America's fighting forces, NORMA-HOFFMANN is devoting all its resources and its 32 years' experience, to the production of PRECISION BEARINGS for the Army, Navy and Air Corps, and for manufacturers of armament and equipment.

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.
BALL, ROLLER AND THRUST BEARINGS • FOUNDED 1911

tion of aircraft courses in school curricula.

"This Bureau has consistently pioneered in the sort of promotion which can best be done by a state government," says CAA. "The increase in flying which will result from the expanded CAA training program is likely to increase this income and make possible still more promotion projects throughout the state."

Along the Apron

"The CAA War Training Service (formerly known as the Civilian Pilot Training Program) will continue," announces R. McLean Stewart, the administration's executive director of training. "The rumor that it will be taken over by the military has no factual foundation. The service is, and will continue to be, the contracting agency through which flight instruction contractors will deal in respect to all matters having to do with the conduct of pilot training programs for the Army and Navy."

Amendments to CAA regulations now provide ratings for aircraft mechanic, aircraft engine mechanic, and factory mechanic. Candidates who have failed examinations for mechanic certificates may apply for reexamination after 30 days. Those who flunked only the test on Civil Air Regulations must also present evidence that they have taken five additional hours instruction in this subject.

Stanford University is giving 25 engineers of Hughes Aircraft Co. advanced training in stress analysis and related subjects necessary for the building of the huge plywood cargo planes suggested by Shipbuilder Henry Kaiser.

In a suggestion for the War Manpower Commission, Pfc. Dudley Holland, AAS En. Br. No. 8, Washington and Jefferson College, Washington, Pa., calls the present labor training program "highly satisfactory" but "insufficient" and asks for a "well planned, continuous program of motion picture training" in which films could be exchanged between appropriate services and industries.

Scholarships in ground training subjects — navigation, engines, radio — for 30 public school teachers have been offered respectively by New York University and Polytechnic Institute of Brooklyn. Applicants must certify their intention to teach secondary school preflight subjects during the next academic year.

First course ever offered to women by Lincoln School of Arc Welding, Cleveland, has been completed by 13 candidates.

Commissioning of two more fields at the Pensacola Naval Air Training Center virtually completes the expansion work commenced there November

Maj. Gen. James H. Doolittle has received the Natl. Aviation Training Assn.'s annual award for high accomplishments in aeronautics.

Instructor's final lecture—Dorothy Love, supervisor of American Export Airlines' first two-week course in company procedures for handling passengers and cargo at home and foreign stations, emphasizes two points just before graduation of class. Seated (left to right): Eliza Gough, Miss Love, and Walter Hitchcock. Standing: George Bright, Natalie Lambing, Pierre Barbet, and Dorothy Arnold.

CIVIL OPERATION AND TRAINING

On Patrol

A bulletin, *Facts about CAP Training,* is being distributed among the Wings by OCD.

Applications for repair parts are now being handled by WPB regional offices, which have been authorized to issue priority ratings up to and including AA-1 on requests valued at not over $500.

A revised edition of Civil Aeronautics Manual 60, *Air Traffic Rules,* is available from the Superintendent of Documents, Government Printing Office, Washington, for 20c.

First civilians ever to receive the War Dept. Air Medal, CAP members Maj. Hugh R. Sharp, Jr. of Wilmington and Lt. Edmond I. Edwards of Newark, Del. (now a naval ensign), have been decorated by Pres. Roosevelt for performing a rescue at sea. When a plane on coastal patrol was forced down, killing the observer, Lt. Edgar Shelfus of Columbus, first CAP fatality on Army service, Sharp and Edwards landed a Sikorsky amphibian in rough water and pulled the other victim, Lt. Henry T. Cross, aboard. The landing damaged the left wing float. To balance the water in it, Edwards rode on the right wing till the plane taxied within range of a Coast Guard boat.

Propellers can also partially produce vegetables, judging from the experience of some Florida flyers. In twelve planes they swooped over 8,000 acres one recent cold night and kept the air circulating so frost would not form.

According to figures in a recent speech made in the House of Representatives by Hatton W. Summers of Texas, the New York Wing is the largest in the nation, with 4,593 members in 6 groups and 28 squadrons. Ohio comes close behind with 4,212 members.

Safety Bulletin No. 148, *Carburetor and Induction Icing,* has just been released by CAB.

Carrying out the CAP program of flying mail to release needed Army pilots, Mrs. Dorothy Hutchings is covering the route between Boise and Pocatello, Ida.

A letter from General Campbell

that we're proud to have you read

ALL COMMUNICATIONS SHOULD BE ACCOMPANIED BY CARBON COPY AND ADDRESSED TO

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON

DEC 22 1942

Mr. R. E. Gillmor, President,
Sperry Gyroscope Company,
Manhattan Bridge Plaza,
Brooklyn, New York.

Dear Mr. Gillmor:

The performance of the equipment which your company has supplied our service for carrying out the past year of combat will undoubtedly be of intense interest to your personnel. It is particularly desired to point out the performance of the Director and Remote Control equipment which your company has supplied for 3" and 90 mm. Antiaircraft Guns.

American troops in the Philippine Islands using the earlier models of Sperry Directors brought down an exceptionally large number of Japanese planes. Sperry equipment performed exceptionally well and contributed largely to the resistance put up in that campaign.

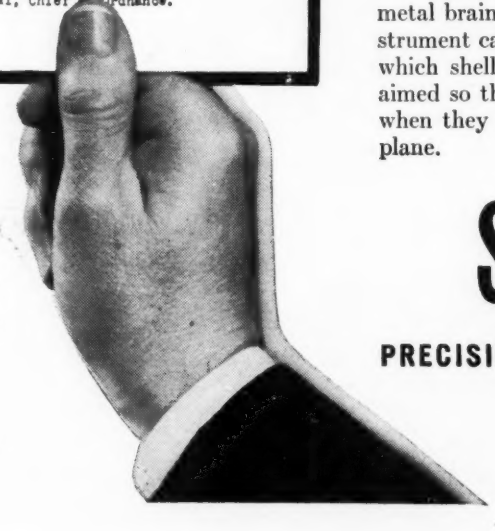
The latest reports come from Guadalcanal in the Solomon Islands where one 90 mm. battery destroyed a total of 16 enemy aircraft in one month using the Sperry Director and Remote Control System. The ammunition expenditure of only 50 to 60 rounds for each plane destroyed is far less than any on record for antiaircraft combat and is a tribute to the Sperry men who have contributed to the extreme accuracy of the director and control. This antiaircraft battery had no trouble in engaging with accurate fire planes flying at high altitudes and has destroyed planes flying at [redacted]

It is suggested that you inform your employees that the equipment which they are building is measuring up to the highest standards and is definitely contributing a part in winning the present conflict. Your company is to be congratulated on the exceptional performance of [redacted] equipment which it produces.

SENT DEC 22 1942 3PDSA 2

Sincerely yours,

L. H. CAMPBELL, JR.,
Major General, Chief of Ordnance.



★ The Sperry Director and Remote Gun-control System are but one example of many ordnance instruments developed through the co-operative efforts of the Ordnance Department and Sperry which enable American guns of all types to fire faster and shoot straighter than those of the Axis.

Sperry Gyroscope Company, Inc.,
Brooklyn, New York
Division of Sperry Corporation

He wrote the letter. Major General L. H. Campbell, Jr., is Chief of Ordnance, United States Army. He knows, from recent trips to the fighting fronts, and by regular reports from the field, how Sperry equipment performs under actual battle conditions.

Iron men plus a metal brain. Crack anti-aircraft crew at their posts with a Sperry Director, the metal brain of the ack-ack guns. This amazing instrument calculates range, transmits firing data by which shell fuses are set and guns automatically aimed so that shells explode at the exact moment when they will do the most damage to an enemy plane.

SPERRY

PRECISION ENGINEERS TO AMERICA

Brawn and Control make the Power TO KAYO TOKYO!

The high qualities of precision, strength and dependability are probably a humdrum prelude to the more deadly "last act and curtains" in the drama of whipping the Axis all over the world.

But . . . rugged prefabricated structures and control elements that go into the finest planes in the world are *necessarily* routine! Routine perfection*ism* is now the only "ism" that really counts.

Machine guns must wheel freely . . . and they must not jam. Landing gear parts must function perfectly so that planes will fight and fight again. Rudders, elevators, flaps and ailerons must have positive and feather-like control for attack and evasion, for take-off and landing. All aircraft parts must be right . . . there can be no second best!

The workers, the designers and engineers, and the management . . . *all* the men and women of GENERAL AVIATION . . . have only one aim: TO KAYO not only TOKYO, but TO KAYO all the enemies of our freedom!

GENERAL AVIATION EQUIPMENT COMPANY, INC.

ASHLEY and WILKES-BARRE, PENNSYLVANIA, U. S. A.

Aircraft Structural and Control Parts

BULLARDS *are Way Up There*

ONLY V.T.L.s HAVE ALL THESE FEATURES:

- Vertical Design Rigidity and Power for Carbide Tools
- 5-Face Turret on Main Head
- Centralized Control
- Rapid Power Traverse of Main Head
- 4-Tool Turret on Side Head
- Simultaneous and Independent Head Functions

America is now rapidly overhauling the Axis in the air. Credit America's productive genius for the amazing speed with which, in one short year, old plants and new have turned out the bombers, the fighters, the transports we need.

Credit too, for a vital share in the achievement, the speedy and accurate Bullard Vertical Turret Lathe. *The greatest single reason we are making 6 times as many V.T.L.s today as in 1940 is the vastly increased demand for them by the airplane engine makers.*

When the war is won, these V.T.L.s will have plenty to do. It will take little time to retool them for the works of peace . . . for in *versatility* too, the V.T.L. is *way up there.*

Airplane photos, U.S. Navy Air Corps.

We like to feel that our Army-Navy "E" award is for work that is helping our customers to earn their "E" too.

THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

Keep UP-TO-DATE On Developments

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save invaluable time, provides profit through convenience. To obtain literature or additional data on new products described, simply fill in form below,* clip it to your letterhead, and mail. There is no cost, no obligation.

Milling and Boring Unit..... 1
From Linley Bros. Co., Bridgeport, Conn., is available color folder concerning company's high speed vertical milling and jig boring machine. Described as both compact and versatile, machine features micrometer screw feed head with direct reading gage.

Aircraft Plastics Bulletin..... 2
Engineering Highlights About duPont's Plastics is new bulletin issued by E. I. duPont de Nemours & Co., Wilmington, Del., containing data on properties and applications of firm's Lucite, Plastacele, Pyralin, Nylon, and Butacite. Aircraft uses are specified.

Vibration Reducers 3
With just-published revised catalog section on its Vibro-Insulators, B. F. Goodrich Co., Akron, includes special engineering work sheet. Latter is aid in providing data preparatory to installations of mountings to reduce vibration, shock, and noise in shop machinery, fittings, etc.

Motor Maintenance 4
Issued by Dumore Co., Racine, Wis., is bulletin *Care and Maintenance of Fractional Horsepower Motors.* Text, photos, and diagrams instruct operator in handling of many service requirements of these units.

Furnace Control Devices..... 5
Binder of bulletins on automatic control instruments for industrial furnaces, kilns, and ovens has been published by Bristol Co., Waterbury, Conn. Loose-leaf form allows for insertion of future additions and revisions regarding units.

Electric Bonding Ring..... 6
Bonding ring designed for use between any electrical plug shell and wire shielding is treated in bulletin being mailed by Cannon Electric Development Co., Los Angeles. Photos and diagrams explain unit, which may be employed with either flexible conduit coupling nut or cable clamp.

Offers Machinery Folders..... 7
Taylor Mfg. Co., Milwaukee, offers literature regarding its Hi-Eff dynamometers, balancing machines, drilling machines, dividing heads, and Hi-Duty drilling machines. Units are described and illustrated in explicit color folders.

Re Turret Mills 8
Profusely illustrated explanatory brochure is available from Rogers Machine Works, Buffalo, N. Y., concerning company's "Perfect 36" vertical turret mills for boring, drilling, and turning. High detail of photographs of machines is feature.

Chart on Fittings..... 9
Special handy-reference wall chart prepared by Weatherhead Co., Cleveland, illustrates company's AN-standard tube, universal, bulkhead, hose, and pipe fittings, also check and selector valves and hydraulic actuating cylinders.

Carbide Tool Maintenance..... 10
Four simple ways to get longer life from cemented carbide tools are graphically shown in red, white, and blue jumbo-size wall poster put out by Vascoloy-Ramet Corp., North Chicago, Ill. Plates on chart deal with critical speed, clearance angles, sharpening, and tool positions.

Adjustable Spacer 11
Released by David J. Ross Co., Benton Harbor, Mich., is bulletin describing operation of Rousselle adjustable spacers for milling machines.

Tool Triumph 12
Documented with illustrations from various war plants is pamphlet on machine tool industry's contribution to war production. Released by National Machine Tool Builders Assn., Cleveland, under title *Machine Tools.*

Hand Tachometers 13
Six single-range centrifugal hand tachometers, with 4 in. dials, cases and accessories, covering ranges from 100 rpm to 10,000 rpm. are shown in Bulletin No. 790 from Herman H. Sticht Co., New York City.

Metal Cutting Manual 14
McKenna Metals Co., Latrobe, Pa., has issued illustrated 52-page pocket manual for metal-cutting-machine operators covering tool applications, designs, styles, and tabular suggestions on grinding wheel speeds.

Graphite Parts Separation..... 15
Usefulness of "dag" colloidal graphite in separating parts without damage is described in Bulletin No. 422-H from Acheson Colloids Corp., Port Huron, Mich.

Die Stamping 16
Dayton Rogers Mfg. Co., Minneapolis, describes its work in new booklet *A Small Lot Metal Stamping Service Without Prohibitive Die Costs.*

AN Connectors 17
Diagrams and Army-Navy-manufacturer's number codes for AN connectors 3100, 3102, 3106, 3108 and AND10066 have been published by Cannon Electric De-

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NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

velopment Co., Los Angeles, in revised *Type AN Electrical Connector Bulletin*, which also contains catalog supplement, descriptions of junction shells, cable clamps, dust caps, and bonding rings.

Plant Protection 18

Highlights of Office of Civilian Defense recommendations for passive protection for industrial plants are contained in *Plant Protection Fact Sheet* issued by OCD editorial section as Publication 5214.

Aluminum Characteristics 19

Yield strength and characteristics of its aluminum alloy castings are listed by Scott Aviation Corp., Lancaster, N. Y., in a pamphlet *Scott-Cast "40-E."*

Electrical Equipment 20

Wartime Conservation is new 96-page book, available from Westinghouse Electric & Mfg. Co., East Pittsburgh, containing tips on conserving motors, transformers, and distribution systems and rebuilding them for bigger loads.

Ryerson Appointed by Aircraft Scheduling Unit of The Aircraft Production Board as

Stock Source

for

Aircraft Alloy Steels

Ryerson Steel-Service Plants in Chicago, St. Louis, Cincinnati and Jersey City are now carrying Aircraft Alloy Steels (Chrome-Molybdenum bars) in stock under the ACW program.

These aircraft steels represent only a small part of the many thousand kinds, shapes and sizes of steels available at Ryerson. Ryerson engineers and metallurgists are always glad to work with you on problems of steel.

X4130 Rounds—Cold Finished—Heat Treated
X4130 Rounds—Cold Finished—Annealed
X4130 Rounds—Hot Rolled—Annealed
X4130 Hexagons — Cold Finished — Heat Treated
4140 Rounds—Cold Finished—Annealed
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and many other alloys.

Aircraft Steels at Chicago, St. Louis, Cincinnati, Jersey City.

Other Plants at: Milwaukee, Detroit, Cleveland, Boston, Buffalo, Philadelphia.

RYERSON

Tap Sharpening .....

Second in a series of educational "talks" from Greenfield Tap and Die Corp., Greenfield, Mass., is an illustrated leaflet on *How to Sharpen Taps.*

Automatic Ferruling .....

New machine for automatically attaching ferrules to low tension, flexible shielding conduit, manufactured by recently established Vaill Engineering Co., Waterbury, Conn., is described in folder now available from company.

Precision Tapping .....

Specifications and features of machines designed to make 2, 3, 4, and 5 gage fits with one pass of tap are presented in book *Bakewell Tapping Machine No.* issued by Bakewell Mfg. Co., Los Angeles.

Collet Chucking Fixture .....

Zagar Tool, Inc., Cleveland, has published booklet illustrating uses and adaptability of its collet chucking fixture for holding and indexing work up to 2 in. round shank in lathes, milling machines, presses, and grinders.

Surface-Angle Plates .....

Distributed by Thomas Wilberton Co., Cedar Grove, N. J., is descriptive bulletin on its bench and floor model combination master surface-angle plates which are guaranteed within .0001 in. tolerance.

Plywood Tacker .....

Simplicity of joining plywood parts with one-hand tacker before molding is portrayed in folder prepared by maker A. L. Hansen Mfg. Co., Chicago.

Conserving Rubber .....

Twenty brief suggestions for conservation of hose, belting, etc., are contained in *How to Lengthen the Life of Mechanical Rubber Goods,* booking being mailed by Pioneer Rubber Mills, San Francisco.

Aluminum Welding, Brazing .....

Aluminum Co. of America, Pittsburgh, has issued illustrated, 100-page book of instructions and suggestions for *Welding and Brazing Alcoa Aluminum.*

Lathe Folder .....

Features of its automatic hydraulic, semi-automatic, mechanical, and manual production lathes, chamfering machines and pneumatic bar feeds are presented in folder from Lipe-Rollway Corp., Syracuse, N. Y.

Blind Riveting .....

In its Handbook A-43, Cherry Rivet Co., Los Angeles, pictures applications, procedures, and tools for fastening its blind rivets in airframes.

Lathe Installations .....

Technical Service Dept., South Bend Lathe Works, South Bend, Ind., has prepared Bulletin H-3 containing illustrations, diagrams, and suggestions for *The Installation and Leveling of the Lathe.*

Aircraft Engine Film .....

From motion picture, Wright Aeronautical Corp., Paterson, N. J., has extracted essence of explanation of engine opera-

on in booklet titled *Cyclone Combustion.* rrangements for display of movie can made through firm's Public Relations ivision.

lectrical Distribution **33**
Enclosed busbar method of electrical istribution is pictured, with specifications nd suggested layouts for feeder and ranch circuits, in Bulletin 427 issued by ullDog Electric Products Co., Detroit.

hemicals in War **34**
Part Turco Products, Inc., Los Angeles, as played in speeding war production s colorfully displayed in folder which lso contains a partial list of firm's spe-ialized industrial chemical compounds.

y" Packing Chart..... **35**
New operating analysis chart for spe-ification and shop record of hydraulic nd pneumatic "U" packings has been ompiled by Wayne Davies & Co., Chi-ago.

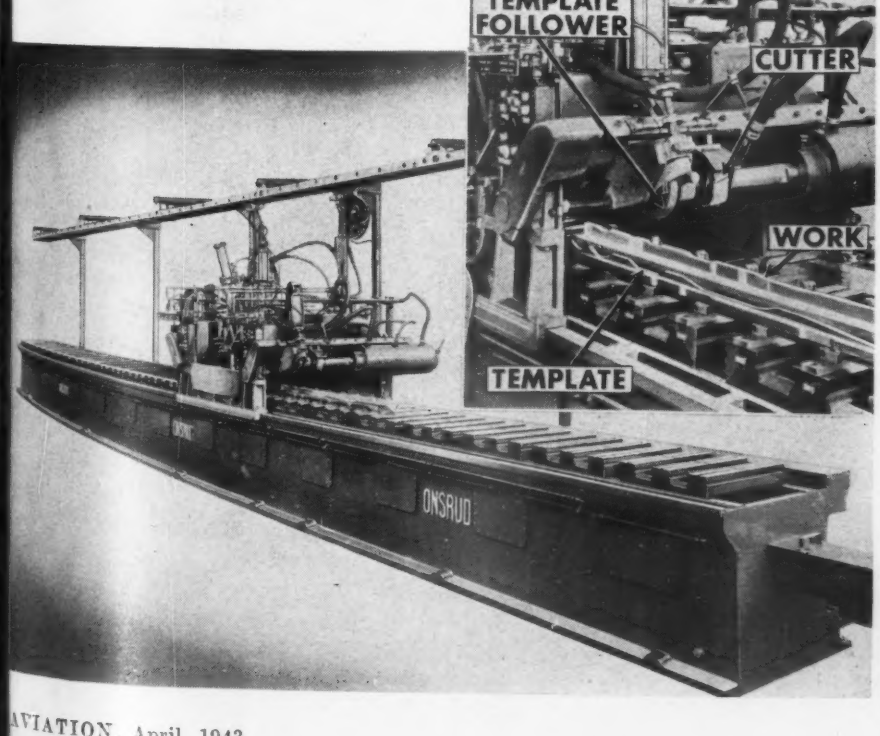
NEW PRODUCTS

Dielectric Parts Treatment **36**
Scintilla Magneto Division of Bendix Aviation Corp., Sidney, N. Y., has prepared new aircraft and automotive service bulletin on *Chromic Acid Treatment of Dielectric Parts.*

Latest Machine Tools

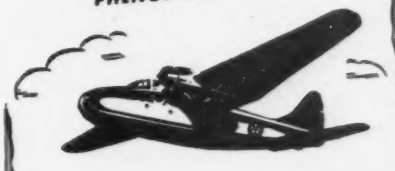
Automatic Contour Miller ... 37

Fast feeding, high speed cutting of ircraft aluminum alloys, extrusions, astings, and billets too large for usual quipment is now possible on the A80-A utomatic contour milling machine, pro-uced by **Onsrud Machine Works**, Chi-ago. Bed is made of 7½ and 15 ft. ections which may be bolted together o any desired multiple length. Open rate 20-in. table sections fastened to ed have "T" slots on 9-in. centers, llowing work to be clamped by air or ydraulic pressure from below table urface. Speed of the carriage, driven y d.c. motor, can be varied from 4 n. to 18 ft. 6 in. per min. Under auto-atic control, carriage speed is regu-lated through rheostat activated by roller following cam bar contoured in relation to work. Controls for the two horizontal and two vertical cutter heads, which can do four simultaneous operations, are mounted on carriage. Cuts are automatically controlled through guides which follow templates set up to desired shape (see diagrammed photo). Reproduction can thus be maintained within .001 to .003 in. Specifications: Length any combination of 7½ or 15 ft.; width 7 ft. 8 in. including trolley and duct posts; weight 45-ft. machine about 52,000 lb.; table 24½ in. wide, height of surface 36½ in. Maximum diameter for horizontal cut-



More Durable, More Foolproof Wood Aircraft Assembly

NOW POSSIBLE WITH NEW NON-ACID "WARM-SETTING" PHENOL RESIN GLUE!



WE invite your inquiries about a newly developed phenol-formaldehyde resin glue which sets new standards for wood aircraft assembly—with these outstanding qualities:

DURABLE—Produces typical boilproof, fungus-proof phenol-resin bond.

NON-ACID—The set film is *slightly alkaline*, far exceeds AN-G-8 requirements. Eliminates known weakening of wood that occurs with use of highly acid catalysts.

FOOLPROOF—Set resin is non-crazing, has good gap-filling qualities. Makes strong bond on joints where perfect fit may be difficult or impossible to attain.

LONG ASSEMBLY—Permits immediate pressing—or up to 1½ hrs. may elapse between application and pressure.

WARM-SETTING—Sets in warm storage room (140° F.).

Since this announcement was made last November, several of America's most important wood aircraft manufacturers have begun experimental use of CASCOPHEN LT-67. Successful production use on special constructions is established.

● We are glad to supply latest information on this new glue to assembly plants, on request. Address: Casein Co. of America (Dept. A4), 350 Madison Ave., New York, N.Y.

CASEIN COMPANY OF AMERICA

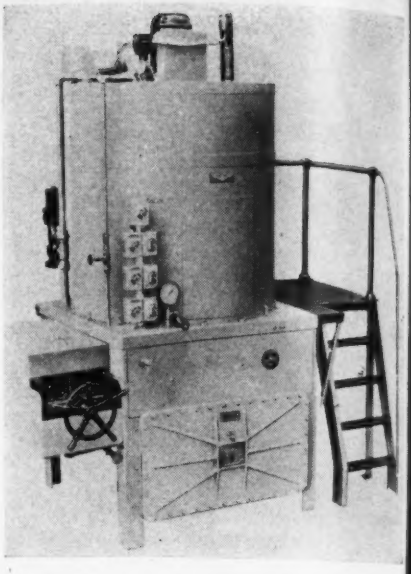
Aircraft Glues

Phenol-resin, Urea-resin and Casein glues to meet all aircraft requirements

ters 9 in., vertical 3 in. Working range from table to vertical motor 2 to 11 in.; working range from table to center of horizontal motor arbor 3¼ to 11½ in. Maximum clearance of work 7 in. high, 20 in. wide.—AVIATION, *Apr.*, '43.

Oil Reclaimer 38

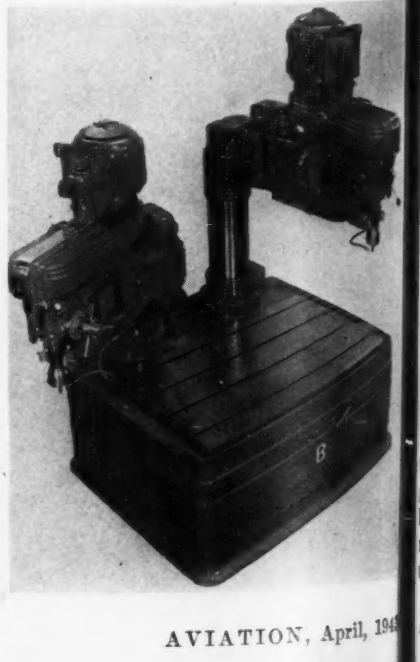
Aircraft lube, Diesel, and transformer oil reclaimers with capacities up to 200 gal. in 90 min. are being marketed by **Youngstown Miller Co.**, Sandusky, O., which report that machines reduce acidity to new oil values and substantially remove asphaltic materials as indicated by ASTM precipitation tests. By extracting contaminates as well, they restore dirty oil to original usefulness. Dirty oil is supplied to machine by automatic float-controlled pump. Operator adds ordinary refiners' earth, turns on electric agitator and heaters regulated by thermostats. Signal lights



indicate when oil and earth have reached proper temperatures. Then operator delivers oil through filter press, removes contaminated earth as dry cake. —AVIATION, *Apr.*, '43.

Double-Head Tapper..... 39

Illustrated here is double-head radial tapping machine manufactured by **Bakewell Manufacturing Co.**, Los Angeles. Combined unit may be used for tapping two different sizes of holes or for working on two different pieces, or one head may be equipped with a drill. Radial arms make possible moving of tap around work. Sensitive clutch designed to prolong tap life, positive depth control, and flexibility in range of materials and work handled are features. All electrical equipment is incorporated in base of the machine, as is also coolant pump. There are two tapping ranges, 71.6 to 376.5 on 60 cycles and 59.3 to 314.0 on 50 cycles (3.08 gear reduction). Tapping capacities: Pipe thread in aluminum, fiber, plastics, brass, and mag-



AIRCRAFT crews in every theatre of war are today depending upon radio operating efficiency for instructions while in the air. Victory or defeat, safety or disaster, often hang in the balance. Astatic Co-axial Cable Connectors and Multi-contact Plugs and Sockets for aircraft radio equipment, make secure contacts and at the same time provide a modern, government approved method of almost instantly connecting or disconnecting electrical circuits. For speed and dependability in installation and service, Astatic products give top performance.

ASTATIC

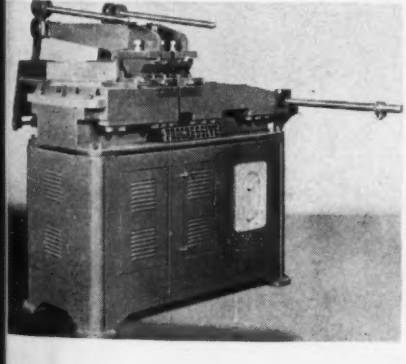
IN CANADA: CANADIAN ASTATIC, LTD., TORONTO, ONTARIO

THE ASTATIC CORPORATION
YOUNGSTOWN, OHIO

nesium ⅛ to ½ in.; pipe thread in normalized nickel and chrome moly steel ⅛ to ⅜ in.; N. C. and F. thread in alumnum bronze, plastics, or softer material 4-40 to ⅞ in.; N. C. and F. thread in mild steels and in nickel and chrome moly steels 4-40 to ⅝ in. Supplied with machines for main drives are single-winding two-speed ½-hp. motors. Maximum distance from center of spindle to columns is 36 in., from spindle to table (spindle up) 28 in., and from spindle to table (spindle down) 12 in. Table size (horizontal) front to back, 28½ in., right to left, 46 in. Height with spindle raised is 93 in. and floor space is 50x55 in. Net weight of double-spindle machine is 5,300 lb., while shipping weight (crated domestic) is 6,300 lb.—AVIATION, *April*, '43.

Flash Welder **40**

Incorporation of "Flash-trol" monitor to prevent arc short circuits is feature of new flash welder produced by **Progressive Welder Co.**, Detroit. When short circuit impends, forward movement of platen is momentarily interrupted, then resumed, thus being de-



signed to avoid line overloading and incomplete welds. Upsetting speed and pressure are provided by booster which forces oil into platen traversing cylinder.—AVIATION, *Apr.*, '43.

Jig Grinder **41**

Manufactured by **Moore Special Tool Co.**, Bridgeport, Conn., is Moore Jig Grinder for finishing holes to size and location after material hardening, and thus increasing die life. Parts of the grinder itself are hardened, ground, and lapped to assure sustained accuracy rated at .0001 in. for straight and tapered holes at angles up to 1½ deg. in

Carrying a Big Load of VICTORY
Accelerated design advances in both planes and engines are meeting war's increasing air transportation demands.
In their continuing forward drive engine designers are assured of the unswerving dependability of U. S. *Super-Positive* Piston Rings—engineered of the finest available material to the most exacting standards—above and beyond print and specification requirements.
Lockheed CONSTELLATION
Wright Cyclone Powered
For Ring Conditions Favoring Peak Performance...
Use U. S. Super-Positives
U. S. HAMMERED PISTON RING CO., INC.
STIRLING, NEW JERSEY, U. S. A.

For every hero—one Blondel

BUT for the faithful Blondel, Richard the Lion-Hearted might never have returned from the Crusades . . . he would have died a prisoner in the Tyrol.

Today's heroes have their "Blondels," too . . . in the plants and factories that supply the equipment for war.

At Fleetwings, for example, the "Blondels" are building planes . . . sturdy Fleetwings' basic trainers for the Army's fledgling bird-men. And they are building parts . . . wings, fins, stabilizers, ailerons, tail assemblies, fuselage sections, and hydraulic equipment for many of America's bombers and fighting planes.

Working with practically every aircraft material . . . with stainless and other steel alloys, with aluminum, with plywoods . . . the men and women at Fleetwings are fighting a supporting action that's felt all the way to Berlin, Rome, and Tokio.

But today's production, vast and important as it is, is not all. The Fleetwings' pioneering that developed the first all-welded, stainless steel military plane is continuing . . . unabated. Victory will find Fleetwings qualified and ready to serve as "Blondel" to the air needs of the Peace.

(Plant No. 1)

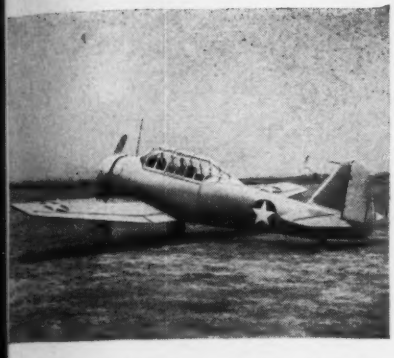
FLEETWINGS

Incorporated

BRISTOL • PENNSYLVANIA

FLEETWINGS

pioneers with parts and hydraulic equipment



The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

NEW ELECTRICAL GAGE, capable of automatically measuring the strain developed during static tests is now in use at Fleetwings to speed the testing of aircraft structures. With this device, it is possible to measure and make a permanent record of the strain developed at 8 different points of a structure—all within a single minute.

THE "DUCKS" HAVE FLOWN from our lofting rooms since the advent of the new Fleetwings-developed Spline-Lock. The Spline-Lock, essentially, is a rubber vacuum cup with a hook or "finger" attached. Primarily designed for holding splines on vertical lofting boards where the old lead weights or "ducks" are impractical, it has been found they are equally efficient on horizontal boards since they hold down the splines much more securely.

FROM THE HYDRAULICS DIVISION comes word of the large variety of tests to which all Fleetwings' hydraulic equipment is submitted before leaving our plants. Every flying condition is duplicated during the tests—and valves function perfectly or are rejected. A "stratosphere box," for example, filled with dry ice, reproduces the sub, sub-zero temperatures encountered in high-altitude flying. Other tests reproduce tropic heat, make sure that the valves are leak-proof and will stand body pressures of 2,500 lbs. per square inch.

"THE ARROW" is the name of the monthly magazine issued by Fleetwings describing production shortcuts and other news of interest to men and women in the aircraft industry. If you'd like a copy each month, write us on your company stationery. Send your request to "The Arrow," Fleetwings, Inc., Bristol, Pa.

"KEEP 'EM FLYING!"

FLEETWINGS

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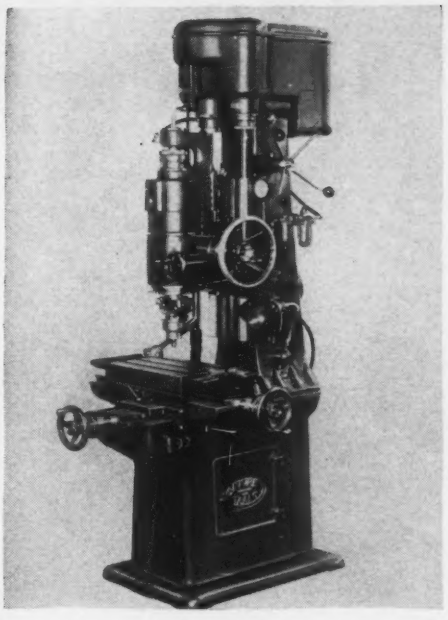
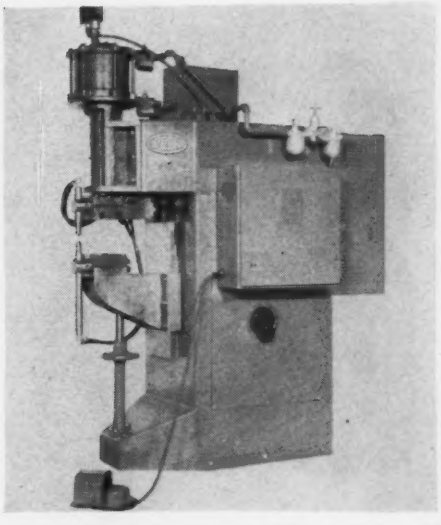
BRISTOL • PENNSYLVANIA



either direction. Other specifications: Table range 9¼ x 14¼ in.; table size 10 x 16 in. (not shown in photo); grinding capacity with wheels, 3/16 to 5 in., with diamond laps 1/32 to 3/16 in.; grinding speeds 15,000, 25,000, and 45,000 rpm.—AVIATON, *Apr.*, '43.

Press Welder 42

Designed for high speed precision projection and general spot resistance welding of sheet and structural steel assemblies, wire, and non-ferrous metals, series P-50 and P-100 automatic, air-operated press type welders have been added to line of **Pier Equipment Mfg. Co.**, Benton Harbor, Mich. Pressures obtained depend upon size of double-acting air cylinder and can be regulated from 800 to 4,000 lb. Platens with "T" slots hold projection welding dies. For spot welding, machines are equipped with two 2½ in. dia. by 8 in. copper horns machined for 1¼ in. water-cooled electrode holders at right angles or offset positions. Standard throat depths 12 and 24 in. Capacities, series P-50,



30 and 50 kva; series P-100, 75, 100, and 150 kva. NEMA types, 1, 2, and 3 timing and sequence controls available.—AVIATION, *Apr.*, '43.

Automatic Riveter 43

To replace hand riveting of heavy aircraft assemblies, bomber spars, and wing skins, **General Engineering Co.**, Buffalo, has devised new automatic multiple riveter (Model G-3000) which sets fastenings at an angle or parallel to axis of motion when pieces are held in a template. Material can be laid out in sequence on motorized feed rolls while the machine is operating. The two heads, fitted with single or multiple anvils, can be run together or separately and easily shifted from automatic to manual control.—AVIATION, *Apr.*, '43.

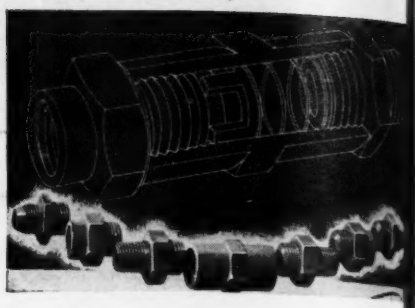
Shop Equipment & Accessories

Stitching Wire 44

Used to bind materials together by method similar to desk stapler, new zinc coated stitching wire developed by **American Steel & Wire Co.**, Cleveland, has guaranteed minimum tensile strength of 290,000 lb. per sq. in., diameter of .051 in. Said to penetrate steel .030 thick, duralumin .040 in., aluminum .060, and softer materials such as rubber, wood, asbestos, and cork to $\frac{3}{4}$ in., wire is reported particularly adaptable to the fastening of rubber, plastics, fibre board, laminated wood and other construction materials to stainless steel or aluminum. "Its use," says firm, "permits stitches to be made at the rate of several hundred per minute. Cold air ducts, first aid kits, and ammunition boxes also can be 'sewed' into their proper places by use of the material." AVIATION, *Apr.* '43.

Check Valve 45

New type universal check valve permitting twelve combinations to be made



with one body and any two of thr types of adapters is now in productio at **American Screw Products**, Los A geles, under trade name "ASP." D signed for airplane hydraulic line valve is described as being 16 perce lighter and having two to four tim greater flow capacity with correspon ing reduction in back pressure. Adap ers available for flared tubing, intern or external threads. Furnished in standard sizes of heat treated aluminu alloy tubing, it can be assembled to me any combination of tubing, connector or fluid flow direction. Laborator tests of 50,000 reciprocations at te peratures up to 275 deg. F. report breakdowns or distortions.—AVIATIO *Apr.*, '43.

Cleaning Fluid 4

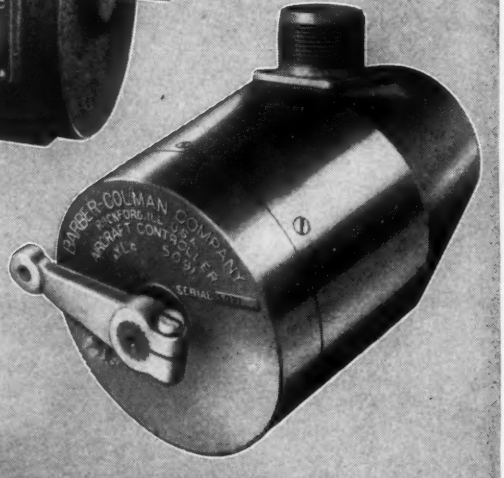
The Curran Corp., Malden, Mass., r ports new cleaning fluid faster tha naptha for cutting gummy, tarry di on metal parts. Intended to repla carbon tetrachloride, it is a wate white methalated hydrocarbon solve described as non-inflammable and no explosive, inducing no corrosion or rus ing in ferrous metals and less tox than tetrachloride.—AVIATION, *Ap* '43.

New Magneto 4

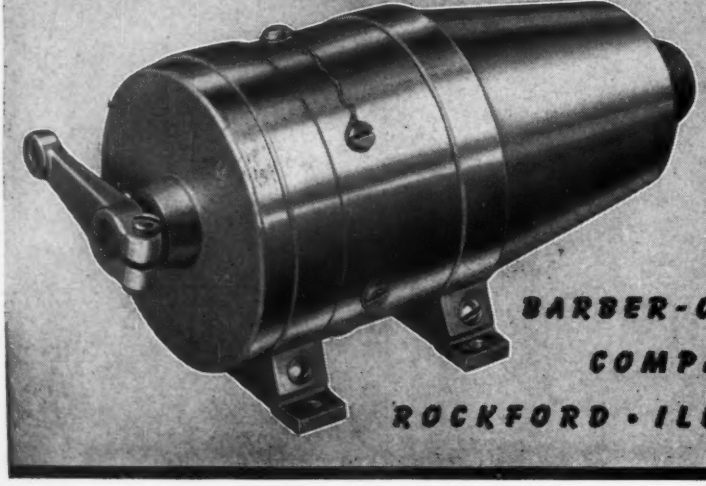
For moderate horsepowered aircra engines, **Edison-Splitdorf Corp.**, We Orange, N. J., is producing 5-lb. ma neto with low sparking performance cranking speeds. Spring mechanism drive end facilitates starting by increa ing shaft speed while retarding spar

BARBER-COLMAN CONTROL MOTORS FOR AIRCRAFT

For positioning flaps and valves on heating, cooling, and air filtering units, and for other control purposes.



B-C Control Motors are specially designed throughout for aircraft service. They are ruggedly built, to exacting specifications, to give proper performance under all operating conditions. They have found wide acceptance by leading aircraft manufacturers. Please write for Bulletin F-1781.

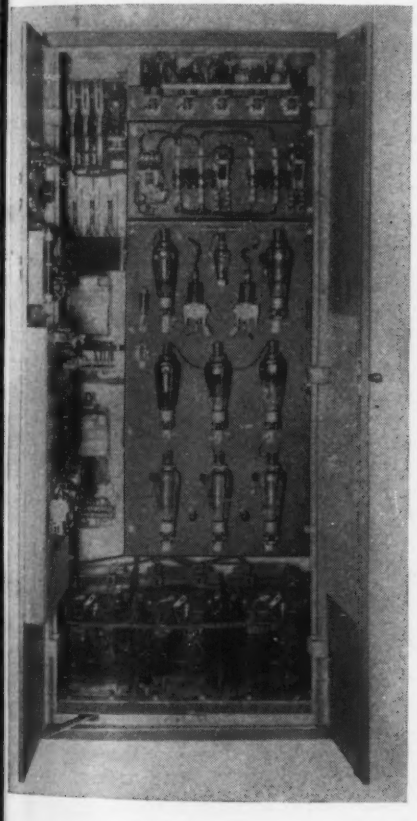


BARBER-COLMAN COMPANY
ROCKFORD • ILLINOIS

Known as Edison Jr. aircraft magneto, it operates by rotating magnet contained in single-unit, die-cast aluminum housing.—AVIATION, *Apr.*, '43.

Welding Control **48**

Simplified construction, eliminating vital materials and facilitating inspection and servicing, is feature of new electronic capacitor discharge resistance welding control announced by **General Electric Co.**, Schenectady, N. Y., for aluminum resistance welding. Employ-



ing energy-storage principle, control provides high currents and short welding time required for this work. It consists of charging and discharging circuits, control station, Pyranol capacitors, and sequence control mounted in cabinet with full-length front doors (open in photo) and removable rear covers. Interior is ventilated by blower. —AVIATION, *Apr.*, '43.

Multitester Unit **49**

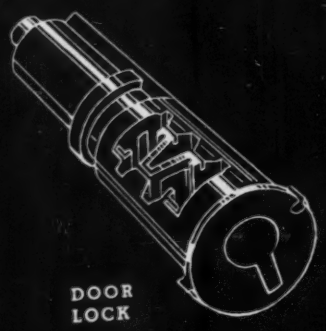
Added to instrument line of **Radio City Products Co.**, New York City, a new multitester (Model 461) has sensi-

CONDUIT FITTINGS
TO ARMY AND NAVY SPECIFICATIONS
PN
The P & N Catalogue includes over 60 pages of conduit fittings—copies are available to aeronautical industry personnel when requested on company letterhead.
AIRCRAFT PARTS & FITTINGS
POULSEN & NARDON, INC.
LOS ANGELES • CALIFORNIA
ESTABLISHED 1922

Win A War Bond! Tell Why

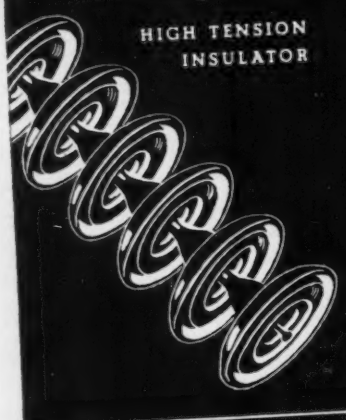
"dag" COLLOIDAL GRAPHITE

IS IMPORTANT in the Manufacture or Use of the Items Illustrated

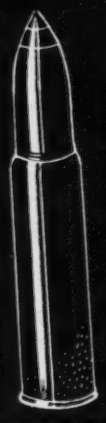


DOOR LOCK

SCREW THREADS



HIGH TENSION INSULATOR



SHELL

How to Win

Acheson Colloids Corporation will give a $25.00 War Bond to each of the 5 people who submit complete and accurate answers together with the 5 best letters on the question, "Why is **"dag"** colloidal graphite important in the manufacture and/or use of the products pictured here?" (1) State business connections (no one in the graphite field or their families will be eligible). (2) All entries must be legible. (3) All entries must state the publication in which the advertisement was seen. (4) Entries must be postmarked not later than June 15, 1943. (5) In case of ties, duplicate awards will be made. (6) Entries become the property of the Acheson Colloids Corp. (7) The verdict of the judges will be final.

"dag" COLLOIDAL GRAPHITE PROVIDES IDEAL RUNNING-IN LUBRICANT

"dag" colloidal graphite applied to bearing surfaces as they are assembled, and blended with the crankcase oil, makes an ideal lubricant for "running-in" engine and compressor cylinders, piston rings, bearings, reduction gearing and valves, etc.

Smoother bearing and rubbing surfaces are obtained . . . less power is lost from friction . . . operating temperatures are lower . . . less oil is needed for complete lubrication . . . danger from temporary failure of oil supply is lessened . . . running-in period is shortened . . . corrosion, especially in cylinders, is reduced or eliminated . . . maintenance and replacements are reduced . . . useful operating life of mechanism is lengthened . . . close tolerances are maintained.

*A TYPICAL APPLICATION

"dag" colloidal graphite is a good solid lubricant. The graphite particles adhere to the metal, forming tenacious "graphoid surfaces" which are so thin that they cannot be measured, and the coefficient of friction of metal on "graphoid surfaces" is little greater than fluid friction.

Furthermore, these surfaces are more easily wetted with oil and films momentarily ruptured are readily re-established.

Write for Booklet 421-H
"dag" Colloidal Graphite for Assembling and Running-in Engines and Machinery

ACHESON COLLOIDS CORPORATION

PORT HURON • MICHIGAN

dag COLLOIDAL PRODUCTS

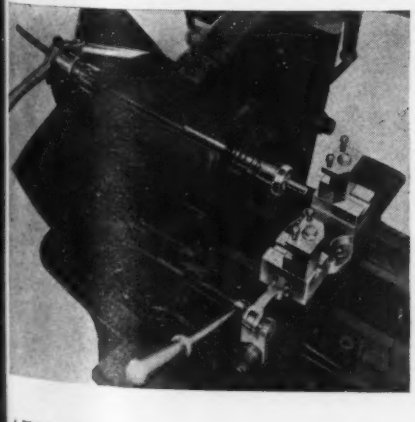
tivity of 20,000 ohms per volt on all d.c. scales, 1,000 ohms per volt on a.c. With over-all size of 7 x 5½ x 3 in., meter has ranges of 0-2.5-10-50-250-1,000-5,000 on d.c., a.c. and output voltmeters; 0-100 on d.c. mieroammeter; 0-10-100-500 on d.c. milliammeter; 0-1,000-100,000-10,000,000 on ohmmeter; and —10 to 50 on decibel meter. —AVIATION, *Apr.*, '43.

Phenolic Plastics 50

Bakelite Corp, New York City, announces new phenolic molding plastic, BM-16034, for long flow extrusion work and transfer molding and new phenolic molding material, BM-13017, designed especially for aircraft and automotive ignition parts.—AVIATION, *Apr.*, '43.

Conversion to Screws..... 51

Designed by **Kessler Aero Products Co.**, Burbank, Calif., to convert small and medium sized lathes into the speed range of hand production screw ma-



A splash of gasoline...a spark...and there's a blaze running amok, threatening vital American battleplanes.

But as soon as the alarm sounds, the peril can end...if a duGas fire extinguisher is near at hand to conquer the fire, quickly and decisively.

DUGAS GETS RESULTS FAST!

In contact with fires, duGas releases great blankets of gases which have a powerful flame-killing effect. DuGas is *always* ready for use in a split-second...it never hardens, freezes or evaporates. Long storage won't cause it to go stale... it is unaffected by damp or dry air. Moreover, its use produces no toxic gases. DuGas is harmless to everything except fire!

duGas

The recently revised duGas wall chart showing the characteristics of all types of Approved Hand Fire Extinguishers is available on request.

Available in Models 15T and 30T Hand Extinguishers, Models 150 and 350 Wheeled Extinguishers.

Write for details and priority information.

DUGAS ENGINEERING CORPORATION • MARINETTE, WISCONSIN

Owned and Operated by Ansul Chemical Company

WANTED!
200 WELDING OPERATORS
IN 10 DAYS
TANK TREAD SHOES, are now welded on assembly lines by women using Westinghouse a-c welders. Treads are positioned in jigs by helpers and swung into welding booths where 34 inches of downhand welding are applied to each.

"We found the answer in untrained women . . . and A-C WELDERS," *says Chief Electrician of Large War Plant*

"Production-line welding in 10 days by women operators who never struck an arc before? A few days ago we would have thought it impossible. *Today, it's a fact!*"

So states this official, who has supervised the training of more than 600 women welders, for producing tank tread shoes on seven continuous production assembly lines. The average woman worker quickly learns how to strike an arc and run short beads—from then on she practices, practices, practices welding tank tread shoes. Usually in ten days she is ready for actual production welding (work must pass bend tests)—where her initial work is carefully supervised by her instructor.

"One of the biggest factors that has made it possible—and successful," says this electrical engineer, "has been the use of a-c welders. We bought them originally because they were immediately available, although we had always used d-c.

"We found, however, that the freedom from arc blow made it much easier to develop qualified operators. Weld quality is excellent. Most important, we've had literally no maintenance in nearly a year of 24-hour-a-day average operation."

★ ★ ★

The 275 Westinghouse a-c 500-ampere welders in operation at this plant are just a few of the many Westinghouse welders that are solving problems of availability, ease of operation and freedom from maintenance for many war plants. Ask for booklet B-3136. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

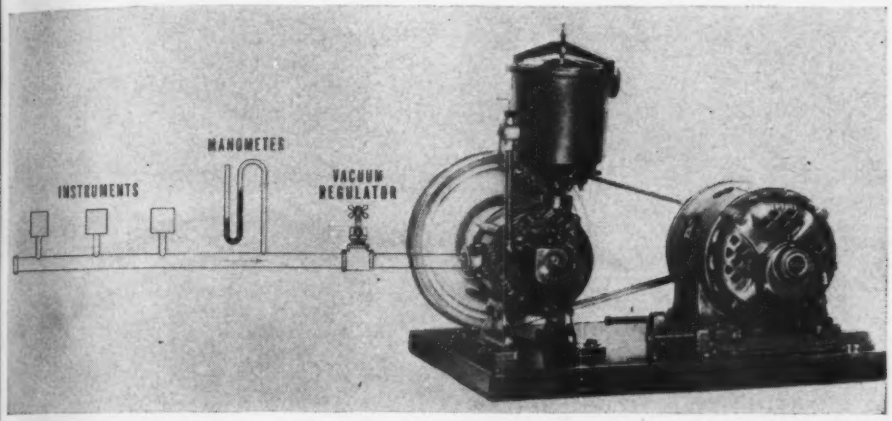
J-21269

Westinghouse A-C WELDERS

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

chines are collet closing attachment and cross slide. Former handles bar and tubing stock from 1/32 to ½ in. dia., chucking and releasing work while lathe runs. Used in conjunction with collet closer, cross slide provides forming and cut-off. Adaptable for Atlas, Craftsman, South Bend, Logan, and similar lathes of ¾ in. spindle capacity.—AVIATION, *Apr.*, '43.

NEW PRODUCTS



Vacuum Tester 52

Furnished by **Leiman Bros.**, Newark, N. J., and designed to test instruments such as directional gyros, artificial horizons, and altimeters is a vacuum and pressure unit (photo above). Machine is slow-running, provided with automatic lubrication and controls to adjust vacuum and pressure as desired.—AVIATION, *Apr.*, '43.

Vacuum Pump 53

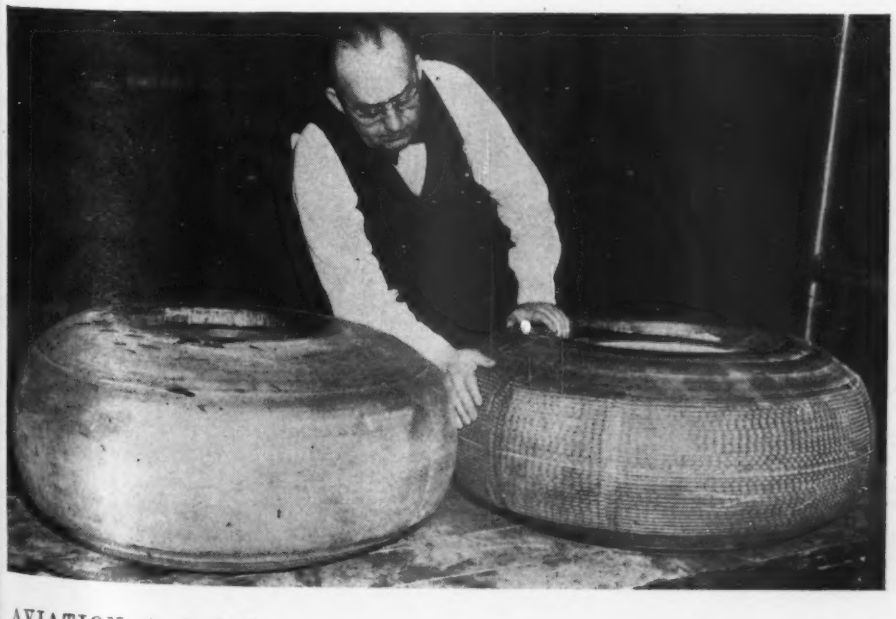
Available from **American Automatic Typewriter Co.**, Chicago, is vacuum pump in two standard sizes, 15 and 7 cu. ft. at 4 in. of mercury. Four bellows, mounted within square wooden frame, are driven electrically through connecting straps attached to a shaft and by a "V" belt to motor. Shaft speed approximately 200 rpm. Both types of pumps are equipped with governors to prevent wear when they have reached their exhaust capacity.—AVIATION, *Apr.*, '43.

Drawing Board Top.....54

No-Ink drawing board top, is special cover for draftsmen's boards, being marketed by **W. H. Long, Co.**, Chicago. —AVIATION, *Apr.*, '43.

Winter-Tread Tire 55

Photo shows C. J. Burkley, **Goodyear Tire & Rubber Co.**, Akron, inspecting carcass of plane tire he designed to reduce skidding on snow and ice. It is encased with wire coils which become tiny ridges when the tread is vulcanized in place.—AVIATION, *Apr.*, '43.

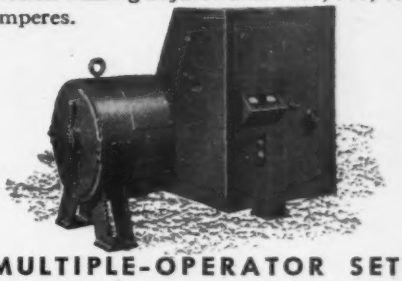


for
PRODUCTION
A-C WELDING

Whether it's a problem of training new operators quickly or of improving present weld quality, Westinghouse a-c welders, with their freedom from arc blow, can help you. 100, 200, 300 and 500-ampere models. Also 1000-ampere models for use with the Unionmelt process.

NEW
D-C WELDER with
ARCONTROL

Single, pre-set current adjustment. Lots of capacity to handle all kinds of work. No drop-off after warming up—less lost motion making adjustments. 200, 300, 400 amperes.



MULTIPLE-OPERATOR SETS

Do the work of 20 to 30 single-operator rotating sets. Stationary types for shop operation—semiportable types for use on shipways and similar applications. Ask for complete data.

PORTABLE
TACKING
PANELS

Compact, single-operator control panels for fit-up work with multiple-operator sets. Extra capacity for light tack welding.

Write for latest literature. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
J-21269

Westinghouse
PLANTS IN 25 CITIES... OFFICES EVERYWHERE
WELDERS

THE *Boost* THAT PUTS THOUSANDS OF H. P. INTO ACTION . . . .

At many bases, under various conditions, the starting of airplane motors often presents real problems. To step up, speed up and conserve starting equipment, "boosters" are used, powered by dependable Briggs & Stratton gasoline motors. This is but one of many "out-of-the-ordinary" applications which, with scores of more familiar uses, make up a most impressive list of ways the armed forces are being served by Briggs & Stratton motors.

As an emergency wartime service, we are trying to route "used" Briggs & Stratton motors that may not now be in service, into the hands of those who need them so badly.

Do you know of any Briggs & Stratton 4-cycle, air-cooled gasoline motors — no matter how old — that are not in active service? If so, please write us, giving sizes, model numbers, and a report as to general condition. We will serve as a "clearing house" to make contacts between owners and prospective purchasers

BRIGGS & STRATTON CORP.
MILWAUKEE, WISCONSIN U. S. A.

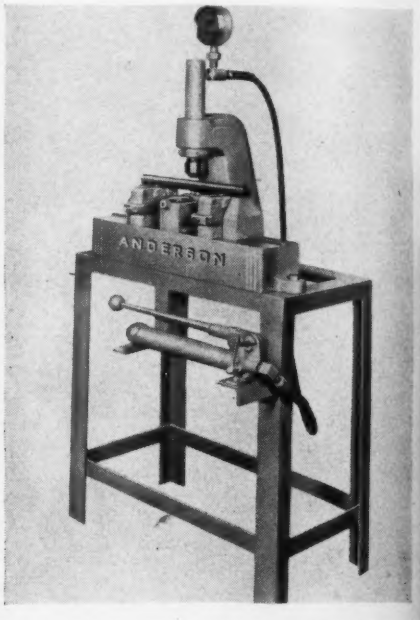
Beat the Axis
Invest in
U. S. War Bonds

4 CYCLE
BRIGGS & STRATTON
GASOLINE MOTORS

NEW PRODUCTS

Straightening Press 56

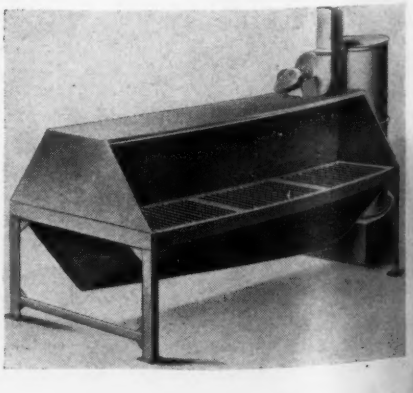
Design of high speed straightening press by **Anderson Bros. Mfg. Co.**, Rockford, Ill., is reported to eliminate necessity of moving shaft from anvils to centers for checking, which is done in

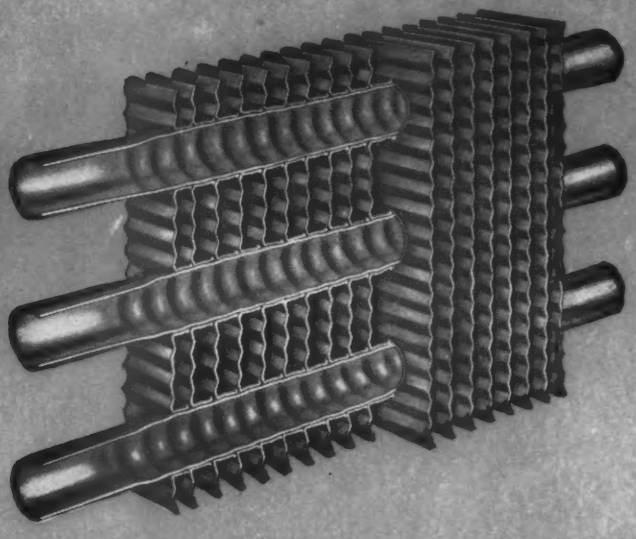


same position as bending. When bending pressure is released, spring pressure on rolls allows shaft to rotate for checking. Indicator gage is calibrated in thousandths of an inch. Pressure supplied by hand hydraulic pump with capacity to 20,000 lb. measured on gage calibrated in lb. Straightener illustrated handles shafts to 1½ in. dia. Manufacturer also plans to produce larger models.—AVIATION, *Apr.*, '43.

Ventilating Benches 57

Claude B. Schneible Co., Chicago, manufactures several models of downdraft ventilating benches, including





THEY'RE SHOCK PROOF

Only McQUAY gives you RIPPLE FIN COILS

More STRENGTH *More* DURABILITY *More* EFFICIENCY *More* HEAT TRANSFER

TO MEET the exacting demands of Navy specifications, McQuay engineers added the Ripple Fin to their Ripple Tube to enable McQuay coils to withstand the shock of heavy guns. This type of construction, together with the all non-ferrous welded header pioneered by McQuay meets the new Navy standards. These shock-proof McQuay coils have been and are being supplied to U. S. Navy yards for the Navy's fighting ships. When you have special heat transfer problems — look to McQuay for the answer. McQuay, Inc., 1624 Broadway Street N. E., Minneapolis, Minnesota.

McQuay INC. . . . . AIR TEMPERING EQUIPMENT ESPECIALLY DESIGNED FOR INDUSTRY

AIRCRAFT ATING ASSEMBLY

CONVECTOR RADIATOR

CANTONMENT HEATING UNIT

VENTILATION HEATERS NAVY TYPE

AIRCRAFT HEATING SECTION

Wherever man goes . . . yes, even from the snowfields of the Arctic, his voice now carries to the outer world through the two-way radiotelephone! In the future, you'll use the radiotelephone as a safeguard, as a convenience, as a business advantage. We are proud of the fact that Jefferson-Travis has pioneered in this form of radio-communication and has contributed to the science of electronics new and exclusive developments that are proving an invaluable aid to the United Nations on every front throughout the entire world.

JEFFERSON-TRAVIS

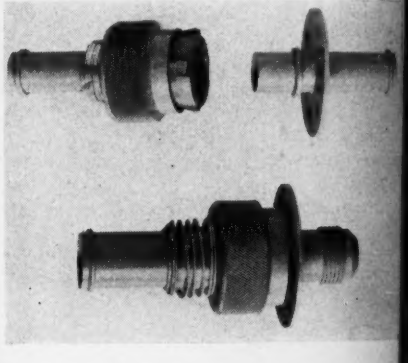
RADIOTELEPHONE EQUIPMENT

NEW YORK · BOSTON · WASHINGTON, D. C.

portable types, for hand grinding, burring and chipping magnesium castings. Working surface is hard wood grating, canopies and end sheets are intended to reduce side drafts and increase ventilation. V-shaped bottom hopper acts as exhaust duct which can be flushed with oil to carry heavy particles to settling tank.—AVIATION, *Apr.*, '43.

Simple Couplings 58

New line of "Quick Disconnect" couplings for fuel, oil, cooling and instrument fluid lines is announced by **E. B. Wiggins Oil Tool Co.**, Los Angeles. Machined from 17ST and 24ST aluminum for aircraft and from bronze for ground use, couplings are available in all required sizes and designs for connecting tubing and hose in any neces-



sary combination. To disconnect, knurled ring is pulled backward, releasing dogs in female half from their grip on locking ring on male half. To connect, the knurled ring is pulled back, compressing a coil spring behind it, and permitting the dogs to open; then the halves are pushed together and the knurled ring is advanced to force dogs down behind locking ring and hold them in that position. Sealing is accomplished by a rubber gasket on a shoulder within the female half.—AVIATION, *Apr.*, '43.

Fire Fighting System..... 59

Carbon dioxide fire extinguishing systems to be installed in engine nacelles are being made by **Walter Kidde and Co.**, Bloomfield, N. J. Gas stored under high pressure in steel cylinders, can be released by valves in crew's compartment.—AVIATION, *Apr.*, '43.

(*Turn to page* 263)

"E" for Excellence

☆ In receiving this joint citation of the Army and Navy, the management and personnel of The Weatherhead Company recognize that the award carries with it not only an honor but a grave responsibility. We will discharge that responsibility by making every effort to increase the flow of vital parts for 'planes, tanks, trucks, ships, combat cars, radios and munitions which Weatherhead plants have been turning out at the rate of millions every day!

Look Ahead with

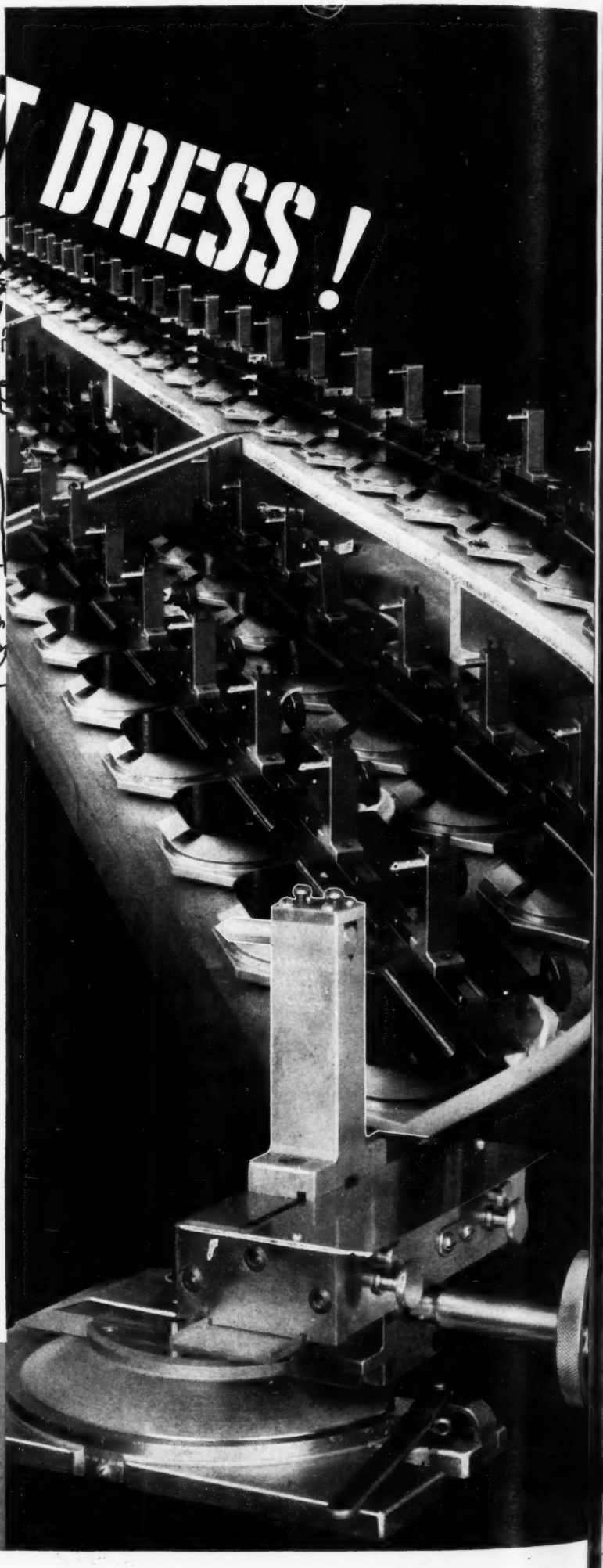
Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND, OHIO

Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Branch Offices: Detroit, Los Angeles, New York and St. Louis

RIGHT DRESS!



RIGHT DRESS* for abrasive grinding wheels is sometimes hard to obtain. When grinding wheels are to be dressed to close tolerances, the dresser must be sturdy, flexible, accurate and fast.

RIGHT DRESS* can be obtained, easily and rapidly, by using the VINCO (B-1) ANGLE TANGENT TO RADIUS DRESSER, which combines all of the above requirements. It incorporates the basic patented principle of dressing radii, angles, and angles tangent to radii on abrasive grinding wheels, from the same axis without removing the diamond.

RIGHT DRESS*, with the VINCO (B-1) DRESSER is accurate to within .0001", reducing time and expense, and giving trouble-free service at all times. This dresser can be adapted for use on all surface grinders, and on most external, internal and cutter grinders.

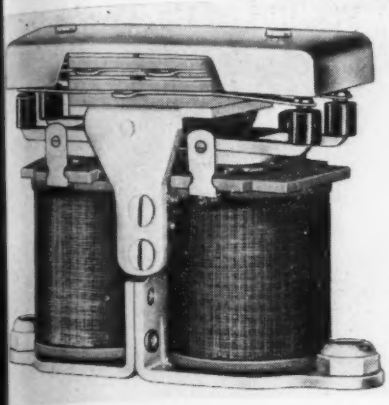
*** Remember, the RIGHT Dresser, the RIGHT operator, the RIGHT grinding wheel, mean the RIGHT DRESS, the correct and accurate form for every dressing operation.**

VINCO CORPORATION

8865 SCHAEFER HIGHWAY
DETROIT • • MICHIGAN

Balanced Relay 60

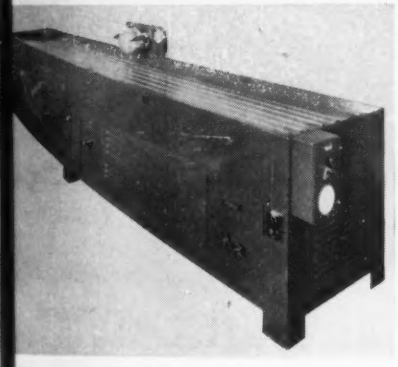
Cook balanced armature relay, made by **Cook Electric Co.**, Chicago, is available with various contact arrangements



up to 12 springs on each side) or micro switches. Capacities up to 5 amp., 110 v. a.c.; coil capacities 10,000 ohms each. Dimensions $1\frac{3}{4}$ x $1\frac{5}{16}$ x $\frac{7}{8}$ in.—AVIATION, *Apr.*, '43.

Hydraulic Test Bench..... 61

Room for two operators and in emergencies provision for accommodating a third is provided at a new hydraulic test bench manufactured by **Hydraulic Machinery Co.**, Detroit. Designed prin-



pally for checking aircraft tubing, bench delivers pressures up to 10,000 lb. per sq. in. and contains variable delivery pumping unit capable of supplying 12 gal. per min. Air-oil accumulator, serviced by small high pressure hydraulic-driven air compressor, seeks valves at maximum of 1,000 lb. per sq. in. and can also charge accumulators already installed in planes.—AVIATION, *Apr.*, '43.

Torque Wrench..... 62

Offered by **Tubing Seal-Cap, Inc.**, Los Angeles, new torque wrench designed for applying proper torque load

to tubing B nuts in aircraft plumbing gives audible and physical signal when pre-determined load has been reached. Employs spring bar deflection principle. Deflection in main bar bends secondary spring which snaps over center when desired load is reached, causing slight drop in torque curve, a click and actuation of button (arrow in photo) in operator's hand. Trade named Livermont Torq-Snap, it will eventually be available in models for use on engine bases, cylinder head and connecting rod bolts, spark plugs, etc. —AVIATION, *Apr.*, '43.

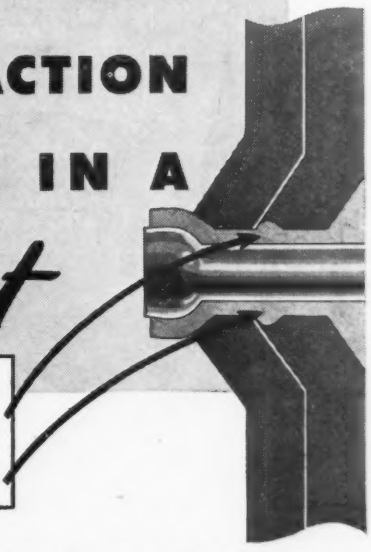
NEW PRODUCTS

Protector Valve 63

To avoid danger of any other unit's stealing pressure from landing wheel brakes, **Dix Manufacturing Co.**, Los

IT'S THE POSITIVE MECHANICAL ACTION THAT COUNTS IN A *Blind Rivet*

Shank expansion fills all irregularities giving high strength to finished rivet



THE CHERRY RIVET HAS THAT ACTION

The self-plugging Cherry Rivet is used in the hard-to-get-at places in new airframe construction, in airframe salvage work and in field repair. No bucking bar is needed. Application is fast and the resulting joint has high shear and fatigue values.

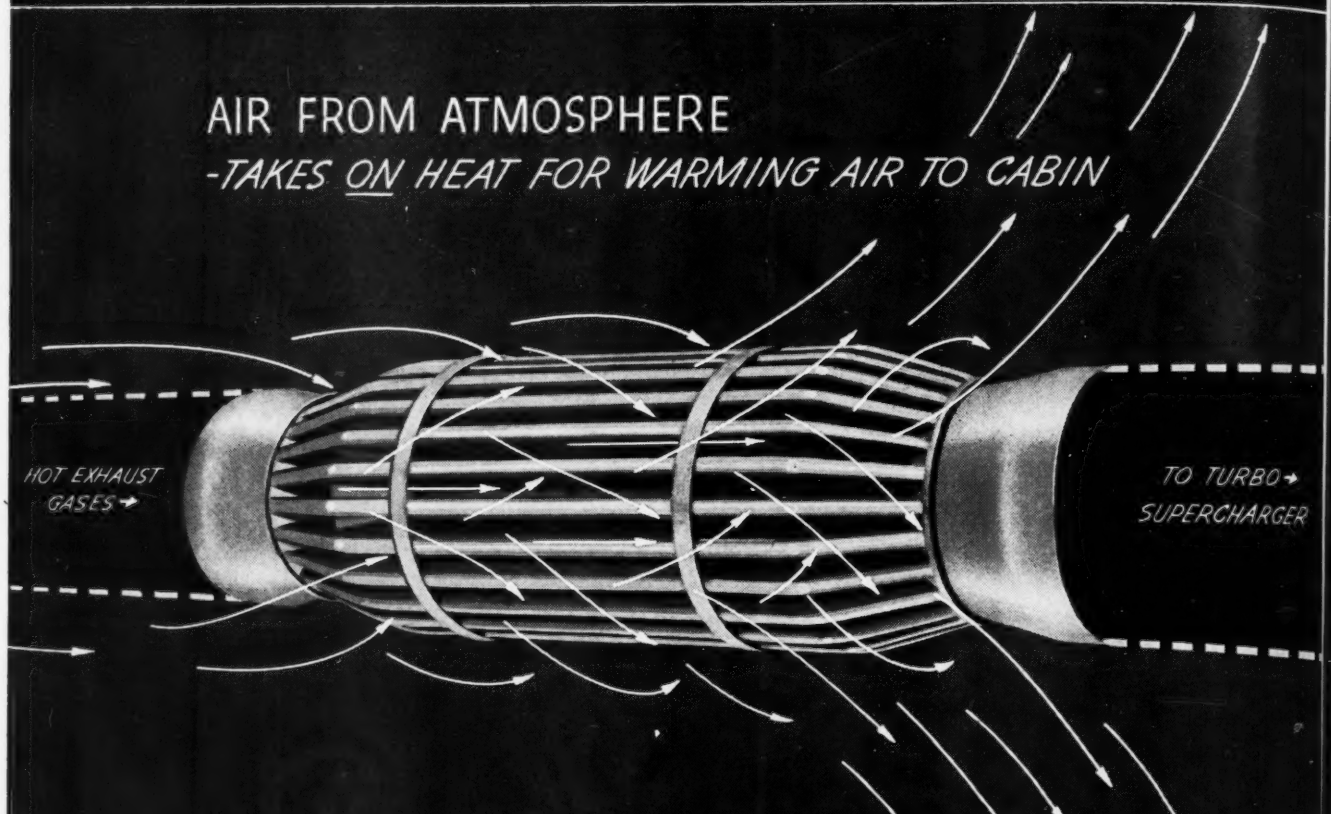
The above diagram of an LS 1128 Countersunk Cherry Rivet in double dimpled sheets shows how the mechanical forces exerted by the mandrel in the riveting process hold the sheets together and expand the rivet shank to fill irregularities in the hole.

WRITE FOR NEW HANDBOOK...
A new 16 page handbook, giving all details on Cherry Rivets and how to apply them, is available on request. Address Department 1, Cherry Rivet Company, Los Angeles, California.

CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U. S. PATENTS ISSUED AND PENDING.

Cherry Rivet Company
LOS ANGELES, CALIFORNIA

With this new Exhaust Heat Exchanger...


AIR FROM ATMOSPHERE
-TAKES ON HEAT FOR WARMING AIR TO CABIN
HOT EXHAUST GASES
TO TURBO-SUPERCHARGER
-TAKES OFF HEAT FOR TURBO FLAME-DAMPING

AiResearch engineering provides *two more advantages* for U.S. aircraft.

"Put controlled air to doing new jobs *... find ways to make it do old jobs better."* This is a special year 'round assignment for one group of AiResearch engineers. And their most recent answer to the challenge is the AiResearch Exhaust Heat Exchanger.

Made of corrosion-resistant steel and simple in design, this new lightweight unit weighs but a fraction more than the section of exhaust pipe it replaces. It is complete in itself, requires no auxiliary equipment. And operates *with little or no drain on engine power* because back pressure is nominal.

To U.S. airplanes, the AiResearch Exhaust Heat Exchanger offers such advantages as these:

Simplified method of Cabin Heating Heated air is ducted from Exchanger through an "interheater"—thus it warms counter-passing air to cabin without danger of carbon monoxide contamination.

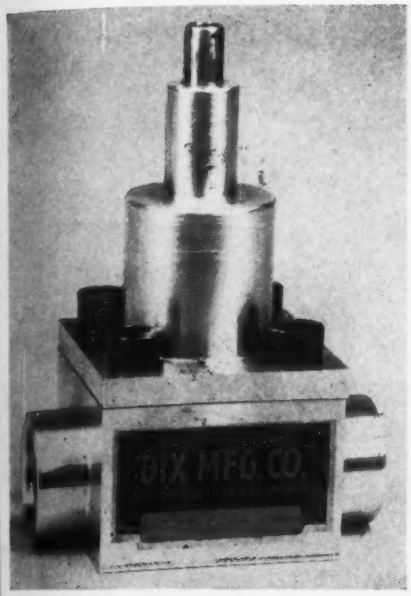
Power-conserving Flame-damping Thanks to its low back-pressure, the AiResearch Exhaust Heat Exchanger can be kept in constant use for cooling turbo-operating exhaust gases. *With practically no loss of engine power!*

This new AiResearch development is now available to all U.S. aircraft manufacturers. Plus the assistance of AiResearch engineers in solving air temperature and pressure control problems for specific aircraft designs. Inquiries are invited.

AiResearch
MANUFACTURING COMPANY
LOS ANGELES, CALIFORNIA
DIVISION OF THE GARRETT CORPORATION

"Where Controlled Air Does The Job" • Automatic Exit Flap Control Systems • Engine Oil Cooling Systems • Supercharger Aftercooling Systems • Engine Coolant Systems

NEW PRODUCTS



Angeles, has developed new hydraulic protector valve. It is fitted with spring adjusted to hold it shut against 700 lb. or other predetermined pressure. Spindle has same area as seat, passes through body, one end being open to atmosphere. Should pressure on delivery side drop below 700 lb., valve shuts, preventing use of other units and reserving whole oil supply for brakes. —AVIATION, *Apr.*, '43.

Chip Picker-Upper..... 64

Illustrated is hand propelled model sweeper of Industrial Sweeper Division of **Moto-Mower Co.**, Detroit, which picks up metal machinings along with

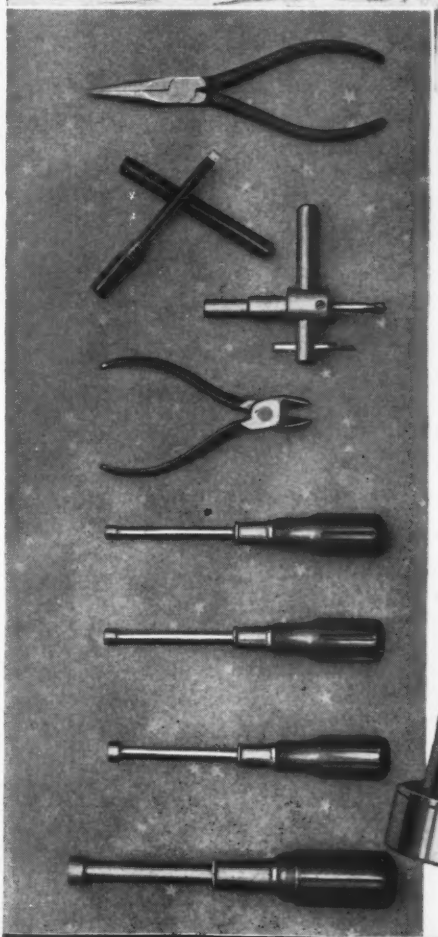
(Turn to page 269)

Speed Working Tools *for Precision Operations*

New and Old Workers find SPINTITE the fastest wrench for speedy assembly of small parts.

Standard sizes with hex sockets from 3/16" to 5/8". Knurled Round and Square Sockets available on special order.

SPINTITE works like a screw driver



751 Set in Leatherette Roll includes 7 SPINTITES 3 screw drivers and chuck type handle

STEVENS WALDEN WORCESTER WRENCHES TOOLS & BOXES

STEVENS WALDEN, INC.

461 SHREWSBURY STREET

WORCESTER, MASSACHUSETTS, U. S. A.

TOMORROW

behind a Wickwire Automatic Propeller

TODAY the only aim of this constant speed, lighter weight propeller is to help win the war.

TOMORROW its *fully* automatic pitch change is destined to help America's family-size planes produce more and faster miles per gallon. By making the operation of such planes *simpler*, and *more economical* it will help to speed the day of universal flying.

WICKWIRE SPENCER AVIATION CORPORATION

Blue Island, Illinois (Subsidiary of Wickwire Spencer Steel Company)

HERE'S PROOF OF THE SUPERIOR PERFORMANCE OF

Gulf Cutting Oils

A FEW OF THE HUNDREDS OF SIMILAR CASES IN GULF'S FILES

Gun Barrels . . . Consulted by a large ordnance plant on the possibility of obtaining greater production in the reaming of cartridge chambers in 1.1 gun barrels, a Gulf Lubrication Service Engineer recommended Gulf Electro Cutting Oil A. Result: production of reamed barrels increased 1500%—rejections reduced 50%.

★

37 Mm. Shot . . . A manufacture of 37 mm. shot increased production 30%, reduced tool regrinds and down time for machine maintenance 50%, reduced cutting oil consumption 50%, and obtained better finishes on the work through the use of Gulf L. S. Cutting Base B blended with Gulf Cut-Aid.

★

Torpedo Gears . . . By using the cutting oil recommended by a Gulf Lubrication Service Engineer, a manufacturer of torpedo parts increased output 41%, improved finish, and reduced rejects in cutting Monel metal gear blanks.

★

Tank Tread Pins . . . A manufacturer of tank tread pins increased production per tool dressing from 85 pieces to 600 pieces by using Gulf Lasupar Cutting Oil C.

★

Artillery Recoil Cylinders . . . By using Gulf L. S. Cutting Base A, a large ordnance plant increased production 30% and increased tool life 300% in machining operations on hardened nickel chrome steel forgings for artillery recoil cylinders.

Bomb Striker Nuts . . . Consulted by a manufacturer of steel striker nuts for bombs on the problem of 100% rejection of production due to torn threads in a tapping operation, a Gulf Lubrication Service Engineer recommended Gulf Lasupar Cutting Oil A and a suitable level on the end of the tap. Result: rejections entirely eliminated, production greatly increased.

★

As a result of proven performance, over a thousand plants with difficult machining operations have adopted Gulf Cutting Oils during the past six months. Here's the record of improved machining practice in these plants: Production increased as much as 300%, tool life increased as much as 2000%, and marked improvements in finish. Write or 'phone your nearest Gulf office today for effective help on *your* machining problems.

GULF OIL CORPORATION · GULF REFINING COMPANY
Gulf Building, Pittsburgh, Pa.

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3800 Gulf Building, Pittsburgh, Pa.

Please send me, without obligation, a copy of the new booklet, "Gulf Cutting Oils," which includes a 24-page Machining Guide.

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Company.....

Title.....

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Internal HEX Wrenching
BOLTS
INCLUDES APPROVED
NASC. SPECIFICATIONS
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FOR Aircraft
FOR YOUR COPY
WRITE DEPT. A4
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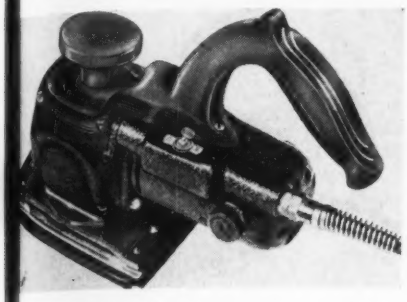
Internal Wrenching BOLTS
THE HOLO-KROME SCREW CORP.
HARTFORD, CONN., U.S.A.

st and dirt at maximum rate of 6,000 sq. ft. per hour in open area. lso available are larger motorized trac- r models (2 and 5½ hp.) with op- onal sulkies.—AVIATION, *Apr.*, '43.

eciprocating Sander.....65

"Nedco" Division of **The Lintern** orp., Berea, Ohio, has developed re- iprocating sander for aircraft wood-



ork at 3,000 oscillations per min. Bal- nced so that it need only be guided ong work, sander comes **ready to plug** to nearest outlet.—AVIATION, *Apr.*, 3.

-Ray Solution Cooler.....66

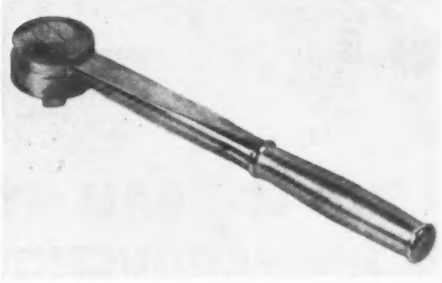
Model 555-PD refrigerating unit, ow being marketed for the cooling of rocessing solution containers in the eveloping tank of industrial X-ray achines, also provides large volume of ater for washing of film, according to anufacturer, **Temprite Products** orp., Detroit. Water circulates hrough system once; on way out passes resh water inlet coil, pre-cooling it nd thus necessitating much smaller re- rigerating apparatus. Then it can be sed in film washing process. Adjust- ent handle on outside of unit (bottom enter in photo) can be set for either

NEW PRODUCTS

usual 65 deg. or 45 deg. for quick cool- ing of fresh chemicals.—AVIATION, *Apr.*, '43.

Socket Wrench 67

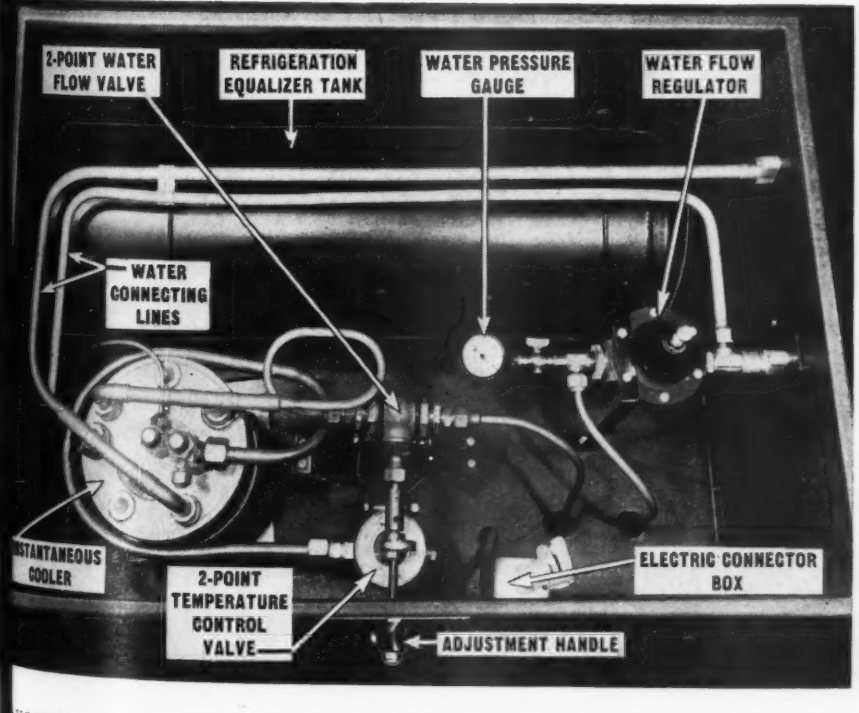
Two free-moving shoes act as clutch in this ratchetless socket wrench, lock- ing for tightening pull at moment han- dle backswing stops. Minimum return motion before engaging is clockwise 1.2



deg., counterclockwise 1.2 deg. Opera- tion reported unaffected by oil or dirt. Obtainable in four sizes, ¼, ⅜, ½, ¾ in. from **F & H Manufacturing Co.**, Los Angeles.—AVIATION, *Apr.*, '43.

New Steel Caster.....68

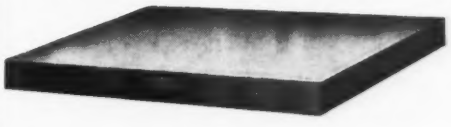
Rapids-Standard Co., Grand Rapids, Mich., is manufacturing "Nicro Steel" caster for portable tanks, dollies, and



BE ACCURATE

Accuracy wins wars—on the battle front and on production front. Promote positive precision with Challenge equipment!

USE CHALLENGE

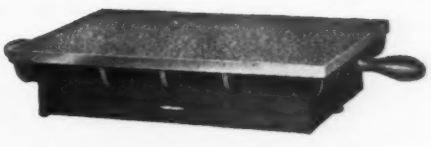


Semi-Steel
BENCH PLATES

These plates provide an accurate surface for assembly, layout and inspection, and tool room operations — particularly on small parts. Made of special analysis semi-steel with all sides machined at right angles to the top. Two, four, and six inches thick. Standard sizes in the two-inch plates range from 8x10 up to 36x84 inches. Four-inch plates from 12x12 to 48x72 inches; six-inch, from 12x12 to 54x144 inches. Either precision ground (up to 36x96-in.) or planer finish. Special and larger sizes to order.

• • •

CHALLENGE SEMI-STEEL SURFACE PLATES



Provide a true surface for tool making, inspection, and testing purposes, also reliable master plates. Challenge Surface Plates are made of strong, close-grained semi-steel, specially heat-treated. They have three-point suspension and heavy, deep ribs on the underside which form triangular supports for the top surface. Will not give or sag under load. Furnished either hand-scraped or precision ground. Felt-lined wooden protective cover supplied with each plate. 433

THE CHALLENGE MACHINERY CO.
GRAND HAVEN, MICH., U.S.A. — 50TH ANNIVERSARY 1893 1943

YOU CAN GET 5 TRU-LOC BALL•TYPE TERMINALS FOR AIRCRAFT IN THE PRODUCTION TIME NEEDED TO MAKE 1 "B" OR "C" TYPE TERMINAL

Further: 1 Type "C" Terminal requires as much Bar Stock as 10 Ball•Type Terminals —the combination of Ball•Type Terminal and the yoke or rod end used with it requires only 32% of the material needed for a Type "C" Terminal—and Ball with shank (as illustrated) plus yoke or rod end cost much less than Type "C" Terminals

Yes, these **TRU-LOC BALL•TYPE TERMINALS** can help you get away from *three* bottlenecks.

1. **They use much less of the critical materials.**
2. **They require but 20% of the productive time—and there is a shortage of automatics used to make terminals.**
3. **You can get them faster.**

There remains but one possible question—the matter of strength. We cover that with the all-inclusive statement that "TRU-LOC BALL•TYPE TERMINALS WHEN PROPERLY SWAGED TO THE CABLE HOLD TO THE RATED BREAKING STRENGTH OF THE CABLE."

The other advantages of **BALL•TYPE TERMINALS**—ease of use in close quarters, etc.—are in addition to the important reasons for adopting them now.

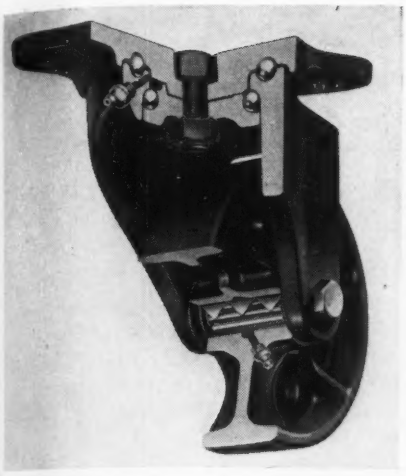
Glad to cooperate with further information. Phone, wire, or write.

• *This illustrated 8½ x 11 folder gives exact data as to sizes, types—most of the facts you will want for your data file. If you do not have a copy, just ask for it.*

AUTOMOTIVE AND AIRCRAFT DIVISION
6-235 General Motors Building, Detroit

In Business for Your Safety

AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT • CONNECTICUT



floor trucks. Featured are two large diameter ball raceways. Casters are furnished with metal or ABK Resinoid floor-protective wheels. Roller bearings are standard in most models, and oilite or porous iron bearings are available for metal wheels. Wheel sizes 3 to 6 in., most satisfactory operating load 400 to 800 lb. per caster.—AVIATION, *Apr.*, '43.

Plastic Drill **69**

First public announcement of new Thor plastic portable electric drill which has been produced for the Army for nearly a year has been made by manu-

facturer, **Independent Pneumatic Tool Co.**, Chicago. Grip handle and field and gear cases are made of specially-developed tough, light weight plastic.—AVIATION, *Apr.*, '43.

Radial Flexible Shaft **70**

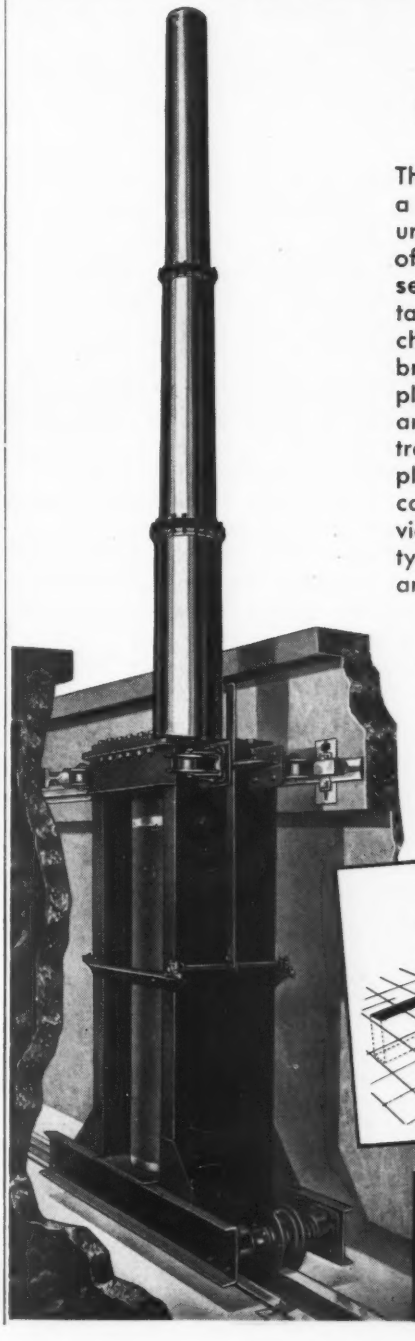
Intended for use where suspension type machines are difficult to hang or where there is no room for bench and floor models, radial type flexible shaft made by **Wyzenbeek & Staff**, Chicago, consists of motor, belt, and flexible shaft which revolve on stationary staff over operator's head. Radial mountings available on all company's flexible shaft machines from ¼ to 2 hp.—AVIATION, *Apr.*, '43.

Felt Finishings **71**

Substitution of felt finishings for rubber, copper, and other critical ma-

terials is exemplified in this photo from **Western Felt Works**, Chicago, illustrating cutaway of new "overcoat" on an important precision-made aircraft part. —AVIATION, *Apr.*, '43.

GLOBE DISAPPEARING HYDRAULIC HOIST ACCOMMODATES ALL PLANES

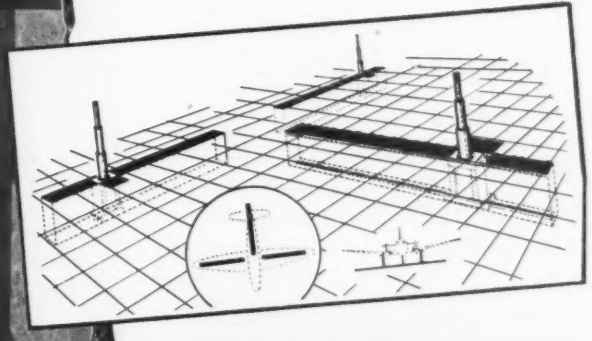


Three Traveling Units, Each 12,500 to 60,000 lbs. Capacity

The Globe Type A-30 Airplane Hoist provides a smoothly operating, easily controlled and universally adjustable means of lifting all sizes of planes **for quicker, easier assembling and servicing.** Hoist, contacting under wings and tail (or nose), is used to "free wheel" plane for checking and repairing retracting mechanism, brakes, tires, etc. . . . or to level and position plane for final adjustment of instruments, armor and controls. The three oil-hydraulic hoist units travel on rails in pits topped with hinged cover plates flush with the floor. Each unit has a lifting capacity of 12,500 to 60,000 pounds and provides a lift to 135 inches from floor level. Other types of Globe Airplane Hoists, both portable and stationary, are shown in a newly published catalog. For your copy, or for further information, write our Philadelphia office: Mermaid Lane at Queen Street.

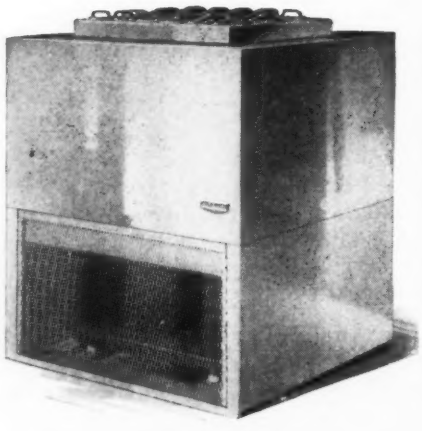
GLOBE HOIST COMPANY

PHILADELPHIA, PA. DES MOINES, IOWA



GLOBE

HYDRAULIC AIRPLANE HOISTS



KOLD-HOLD Rivet Machine

Cuts Rejects!

Keep aluminum alloy rivets in anneal at –45° F. and cut inspection rejects as much as 10% to 50% . . . with KOLD-HOLD Rivet Storage Machines.

Stored rivets drive faster, are less subject to head cracks — fewer have to be drilled out and replaced. Speed production, too, with rivets stored right where they are used. Handy tube assembly classifies rivets—permits storage up to moment of use.

Where large quantities of rivets are used, large KOLD-HOLD rivet storage units are at annealing stations, and small portable KOLD-HOLD units carry rivets to departments.

Whatever your rivet storage or industrial sub-zero processing problems may be, investigate KOLD-HOLD. Get complete details, NOW.

New York — 254 W. 31st St. — Penn. 6-1161
Chicago — 201 N. Wells — Randolph 3986
Los Angeles — 1015 W. Second — Mich. 4989

KOLD-HOLD MANUFACTURING CO.
442 N. Grand Ave., LANSING, MICH., U.S.A.

Duct Clamps 72

Lightness and "a positive equalized circumferential loading that exerts equal pressure at every point," are features reported by **Marman Products Co.**, Inglewood, Calif., regarding new

line of air and oil duct clamps. With diameters ranging from 1⅜ to 38 in., clamps are made for square, oblong, circular, and triangular joints in hot or cold lines and can be installed without breaking joint.—AVIATION, *Apr.*, '43.

Rivet Retriever 73

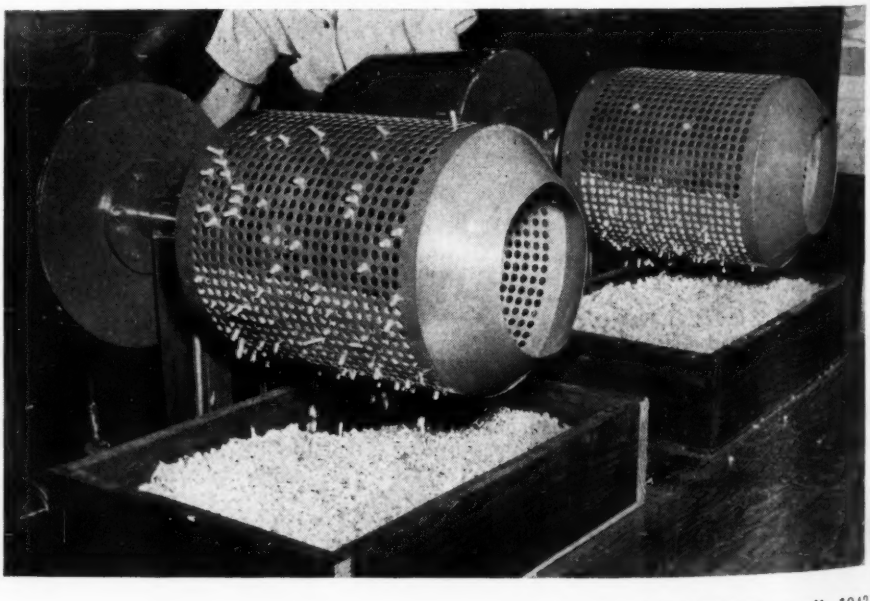
Blueprints for a machine which sorts according to thickness, head type, and length aircraft rivets dropped by workmen are available from **Fisher Body Division of General Motors**, Detroit, which developed device. Here rivets are being sorted for thickness. Similar barrels have been perforated to classify rivets of every thickness used in Fisher plant. Other machines then sort for head type and length.—AVIATION, *Apr.*, '43.

Acetylene Generator 74

Newly introduced in this country by **Adler Manufacturing Co.**, Milwaukee, is acetylene generator employing the lump carbide immersion principle. Available in two sizes, 90 and 200 cu. ft.; shipping weights 70 and 120 lb., respectively.—AVIATION, *Apr.*, '43.

Tire Tool 75

Tire remover tool of **New Britain Machine Co.**, New Britain, Conn., is reported fitted for all standard drop center rims on planes, cars, busses, and tractors. Pressure on heel bead throws tire bead into drop center well of rim, and flat ends are then employed to remove tire. Length 18 in., weight 3 lb.—AVIATION, *Apr.*, '43.



Redesigning packing cases saves steel and shipping space

Information supplied by an Industrial Publication

A case in point is what has recently been done by a large manufacturer of airplane engines with respect to a matter normally considered of small importance.

New packing cases have been designed which feature simplicity of construction, added strength and materials-conservation. Concerning the latter — an extremely important matter right now — it was found that the substitution of two thin metal bands for the former outside bolted steel strapping and lifting eyes has saved over 500 tons of steel annually.

A slight reduction in the overall dimensions of one size of case now permits 20 cases of this size to be packed inside a typical freight car, whereas only 10 could be so packed formerly. Countersunk case handles, and the elimination of other previously-used protruding hardware, offers a smoother exterior, more compact storage, and less likelihood of damage to adjacent cases.

Simplified design makes it possible for four basic cases to care for the shipment of all engine types, whereas eight were formerly needed.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE BRIQUETTES • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

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MOLY

Guided by the stars toward their "target for tonight" . . .

by

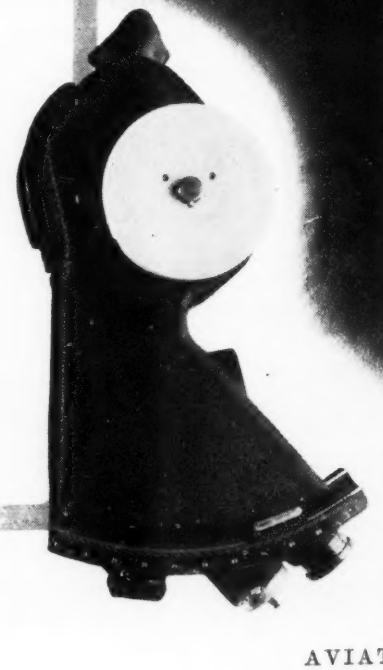
WEEMS
STAR CURVES

THE WEEMS SYSTEM OF NAVIGATION was established in 1928 and is based on the patents, copyrights, and developments of Lt.-Commander P. V. H. Weems. It has been expanded to cover the entire of field and sea and air navigation. The outstanding contributions by Commander Weems include the Star Altitude Curves, the Line of Position Book, the Second-Setting Watch, the Gold Medal Text Book *Air Navigation,* Marine Navigation, improvements in the Bureau of Standards Type Aircraft Sextant, the Design of the Air Almanac, numerous articles, etc., etc. To those interested in celestial navigation we will be pleased to send complete data fully describing the books and instruments used connection with the Weems System.

WEEMS SYSTEM OF NAVIGATION
ANNAPOLIS, MARYLAND

● *EQUIPMENT SUPPLIED BY WEEMS SYSTEM OF NAVIGATION*

WSN Speed-Time-Distance Calculator.
Navigation Note Book & Plotter, *Weems.*
Aircraft Plotter, Mark II.
Simplified Celestial Navigation, *Weems and Link.*
Air Navigation Outline, *Keator.*
Line of Position Book, *Weems.*
Illyne Star Chart, with booklet.
Air Almanac, for 4 months.
Radius of Action of Aircraft, *Tornich.*
Marine Sextant.
Second-Setting Watch.
Marine Navigation, *Weems.*
Link Averaging Bubble Sextant.
Instrument Flying, *Weems and Zweng.*
WSN Course and Distance Protractor.
Air Navigation, *Weems.*
Star Altitude Curves, *Weems,* per 10° Lat. Band.

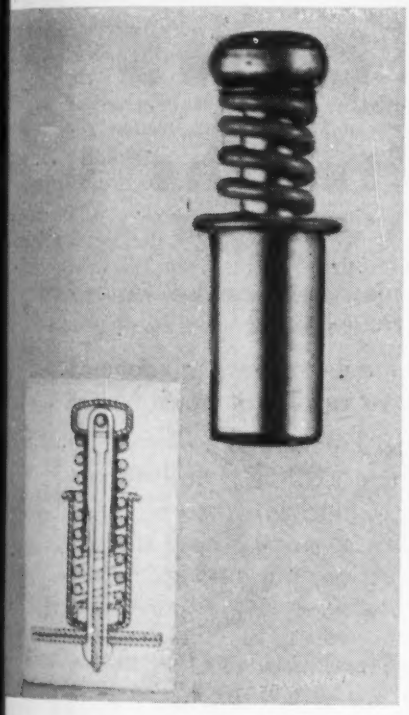


LINK AVERAGING BUBBLE SEXTANT

NEW PRODUCTS

Skin Fastener **76**

Reduction in worker fatigue by principle of compression of aircraft skin fastener after insertion instead of before is feature of new device marketed by **Scovill Mfg. Co.**, Waterbury, Conn. Heat treated case to reduce wear by pliers is, in use, gripped by standard fastener pliers and wedge inserted in holes where it acts as leader, lining them up. Then fastener is compressed. An audible snap indicates that it has locked into place. Complete filling of the hole



prevents lateral motion of fastener, and spring compensates for various thicknesses of sheet. Made of non-critical materials, fasteners are available for holes, 3/32, 1/8, 5/32, and 3/16 in. dia. Majority of parts used in these sizes are interchangeable.—AVIATION, *Apr.*, '43.

Grinding Fixture **77**

New relief grinding fixture designed to speed up countersink grinding operations has been designed for aircraft industry by **Industrial Grinding Co.**, Los Angeles, Calif. Will handle countersinks of all types, center drills, integral pilot cutters, and pilot drills, either right or left handed; fits any standard grinder on work from 1/16 to 1 in. dia. Lift of single cam is variable from .001 to 1/8 in. and adjustment pins are provided for 1, 2, 3, 4, 6, and 12

Arteries for a Fighting Heart!

REX-FLEX Stainless Steel Flexible Tubing is battle-tried and proven—at the heart of the giant motors which power the Boeing Flying Fortress—on equally important applications on many other of our latest, largest and most formidable military aircraft.

In aircraft production the adaptability of REX-FLEX for installation facilitates the flow of parts through manufacture to assembly and speeds the convergence of major units into final assembly.

REX-FLEX characteristics of light weight, strength, flexibility, and resistance to corrosion, heat and vibration are solving an ever increasing number of vital problems in aircraft design and construction. Like the accomplishments of the aircraft industry itself, the application developments of REX-FLEX, considered impossible mere months ago, are commonplace production line assemblies of Chicago Metal Hose Corporation.

Write for Engineering Recommendations

CHICAGO METAL HOSE CORPORATION

General Offices: MAYWOOD, ILLINOIS

Factories: Maywood and Elgin, Ill.

Thanks to the

SUNNEN PRECISION HONING MACHINE

GIRLS IN 'TEENS

are handling jobs in "tenths"!

Aluminum Aircraft Link "produces high finish without bell-mouthing."

Inner Bearing Ring "Accurately removes last 'tenth' of stock."

Bronze Valve. The Sunnen method of honing is used to secure a high finish and accuracy.

Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."

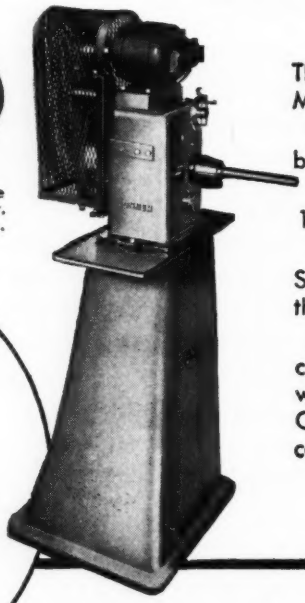
Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.

Aircraft Valve Tappet Roller. 4-Micro finish.

and what's more remarkable, they can be trained for such accurate work in a few hours.

That's only one reason manufacturers of combat equipment and munitions have adopted the SUNNEN Precision Honing Machine.

The guaranteed accuracy (.0001″) and super-smooth finish (2 to 3 micro inches) assure fewer rejects and interchangeability of parts. These advantages not only speed production, but prevent waste of vital war materials.



Low in Cost—Economical to Operate

The basic price of the Sunnen Precision Honing Machine is only $195! And it's economical to operate.

No jigs or fixtures—work is held in hands. Relieves big internal grinders for other jobs.

Wide range—handles any internal diameter from 185″ to 2.400″.

Protect your previous operations by using the Sunnen method for that most important operation—the last one.

It's easy to find out just what Sunnen equipment can do for you on your job—one of our engineers will be glad to call and help you solve your problems. Or—if you prefer—write for free bulletin giving complete information.

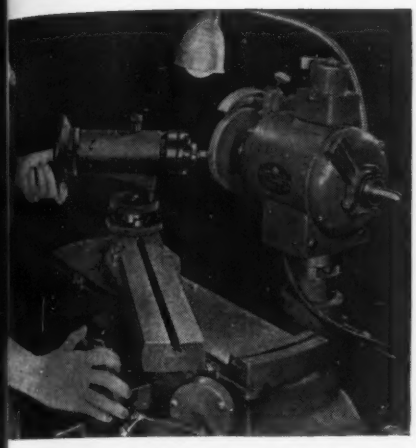
The coveted Army-Navy "E" waves over the Sunnen plant—evidence of the important part Sunnen equipment is playing in the war effort.

SUNNEN

SUNNEN PRODUCTS COMPANY, 7942 Manchester Ave., St. Louis, Mo.

Canadian Factory: Chatham, Ontario

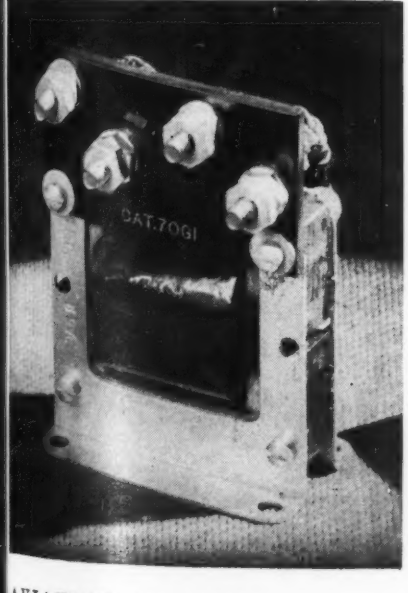
NEW PRODUCTS

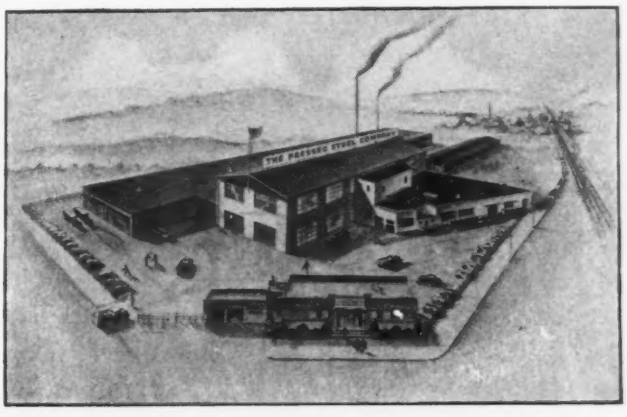


fluted cutter grinding. Main housing is of high grade cast iron, which supports a hardened and ground spindle on two large bearing surfaces that require only periodic oiling. Cam is hardened tool steel, with steel adjustment pins. Fixture swings 90 deg. to right or left, and base is calibrated in 5 deg. increments.—AVIATION, *Apr.*, '43.

Light Transformer 78

Hardly bigger than a match box, indicator light autotransformer developed by **General Electric Co.**, Schenectady, N. Y., can supply power for 52 bomb indicator lights of .19 amp. Each of two models, 115 or 26 v., operates on 400-cycle, single-phase supply, delivers 30-va at 3 and 1.5 v. Tap of latter voltage provides for lamp dimming, prevents premature filament burnouts when only part of lamps are lighted. Size





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CARBURIZING AND HEAT TREATING EQUIPMENT

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SEAMLESS STEEL CYLINDER CAPS AND NECK RINGS

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WELDED ALLOY TUBING FOR HIGH TEMPERATURE CORROSIVE APPLICATION

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RADIENT TUBES, INNER COVERS AND BASE SHEATHS FOR STEEL MILLS

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DETROIT, 312 Curtis Bldg • CHICAGO, 205 Engineers Bldg.
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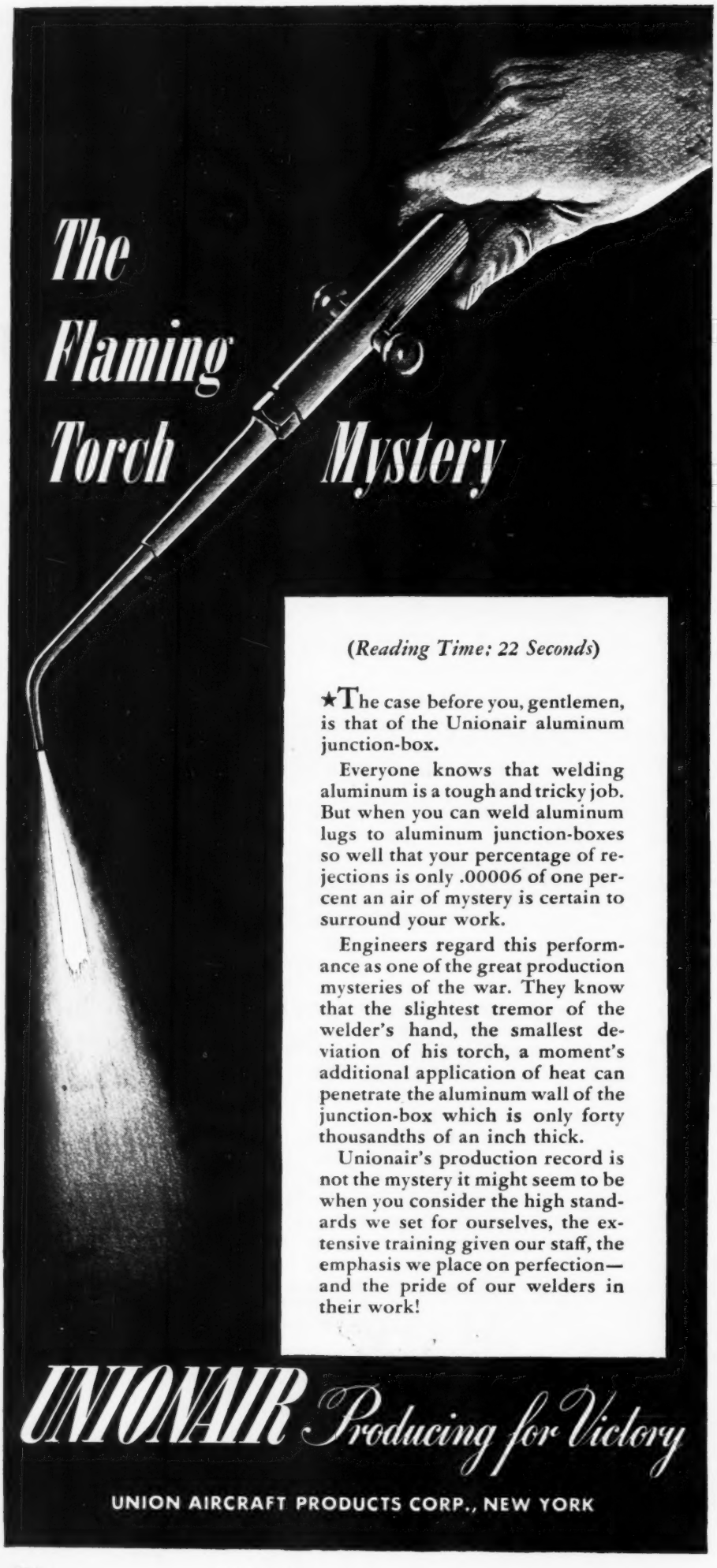


(Reading Time: 22 Seconds)

★The case before you, gentlemen, is that of the Unionair aluminum junction-box.

Everyone knows that welding aluminum is a tough and tricky job. But when you can weld aluminum lugs to aluminum junction-boxes so well that your percentage of rejections is only .00006 of one percent an air of mystery is certain to surround your work.

Engineers regard this performance as one of the great production mysteries of the war. They know that the slightest tremor of the welder's hand, the smallest deviation of his torch, a moment's additional application of heat can penetrate the aluminum wall of the junction-box which is only forty thousandths of an inch thick.

Unionair's production record is not the mystery it might seem to be when you consider the high standards we set for ourselves, the extensive training given our staff, the emphasis we place on perfection—and the pride of our welders in their work!

UNIONAIR *Producing for Victory*

UNION AIRCRAFT PRODUCTS CORP., NEW YORK

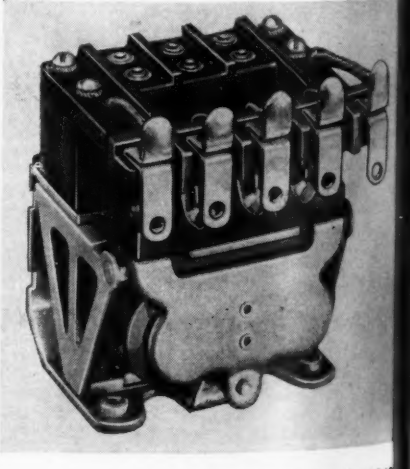
2¼ x 3¼ 1½ in., weight 13¼ oz. Operating range: Sea level to 60,000 ft. -40 to 140 deg. F.—AVIATION, *Apr.*, '43.

Resurfacing Alloy 79

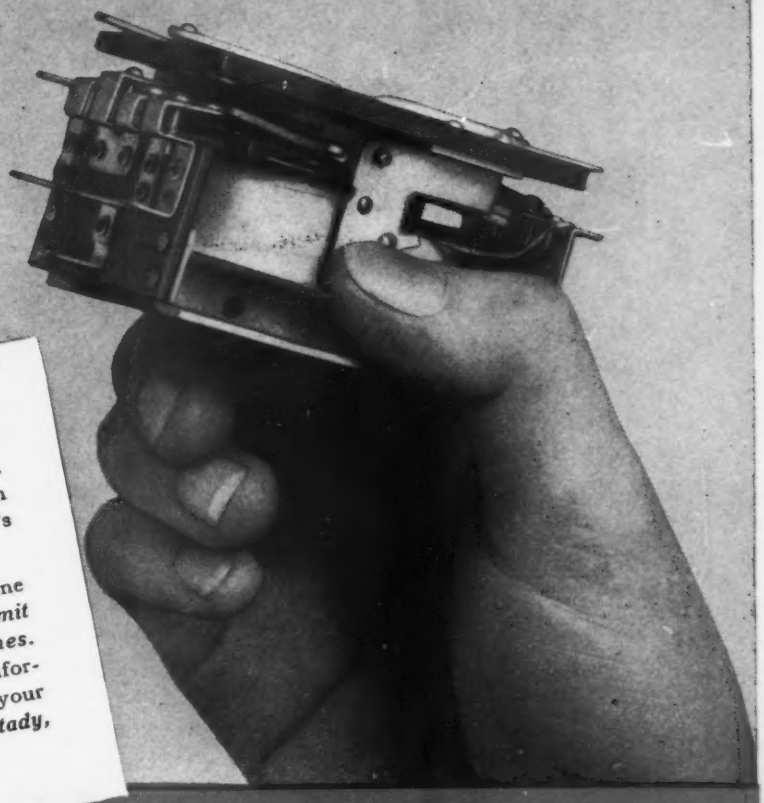
Durface is name of ferrous alloyed welding material for resurfacing worn alloy steel, cast and malleable iron machinery. It is produced in two grades for gas and electric welding (a.c.-d.c.) by **Eutectic Welding Alloys Co.**, New York City, which report following physical properties: Gas hardness 450-500, tensile strength 50,000 lb. psi.; electric hardness 575-675, tensile strength 50,000 psi. Photo indicates refinished part.—AVIATION, *Apr.*, '43.

Small Relay..... 80

Developed particularly for aircraft, new G-M 3PDT type 27 relay is 2 x 1⅞ x2⅛ in., weighs 5 oz. Acceleration, 15g-plus; nominal coil voltage, 12 d.c.; pick-up, 6.5 v. (.92 w.) at 20 deg. C.

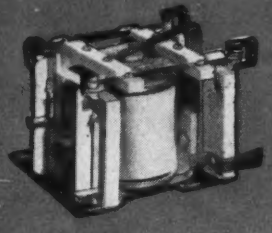


LOOKING FOR AIRCRAFT RELAYS?

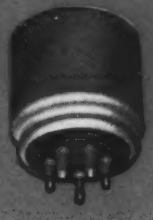


MORE than 25 different types of aircraft electric relays are now either in production or in final design at General Electric. Every one of these relays—a few are shown below—meet the U. S. Army Air Force's requirements for aircraft electric devices.

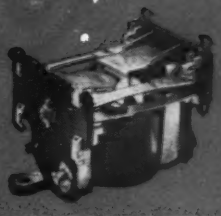
We now also have in production a full line of aircraft controls including *contactors, limit switches, solenoids,* and *pressure switches.* Our new catalog gives full descriptive information on all of these devices. Send for your copy today. *General Electric, Schenectady, New York.*



HIGH-VOLTAGE RELAY
CR2791-D100F
Contact Rating—0.020 amp, 1000 v, d-c

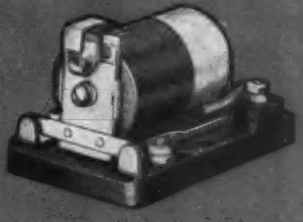


SENSITIVE RELAY
CR2791-C10JC
Contact Rating—2 amp, 24 v, d-c

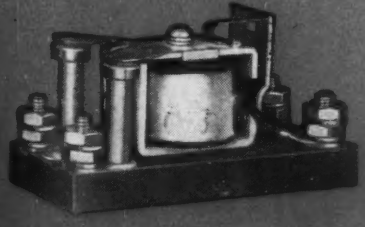


MULTIPOLE RELAY
CR2791-G100K
Contact Rating—10 amp, 12 or 24 v, d-c

DUST-TIGHT RELAY
CR2791-M100
Contact Rating—10 amp, 12 or 24 v, d-c



TIME-DELAY RELAY
CR2791-J102B
Contact Rating—20 amp, 12 or 24 v, d-c



25-AMPERE RELAY—TYPE B2A
CR2791-A100A
Contact Rating—25 amp, 12 or 24 v, d-c

GENERAL ELECTRIC

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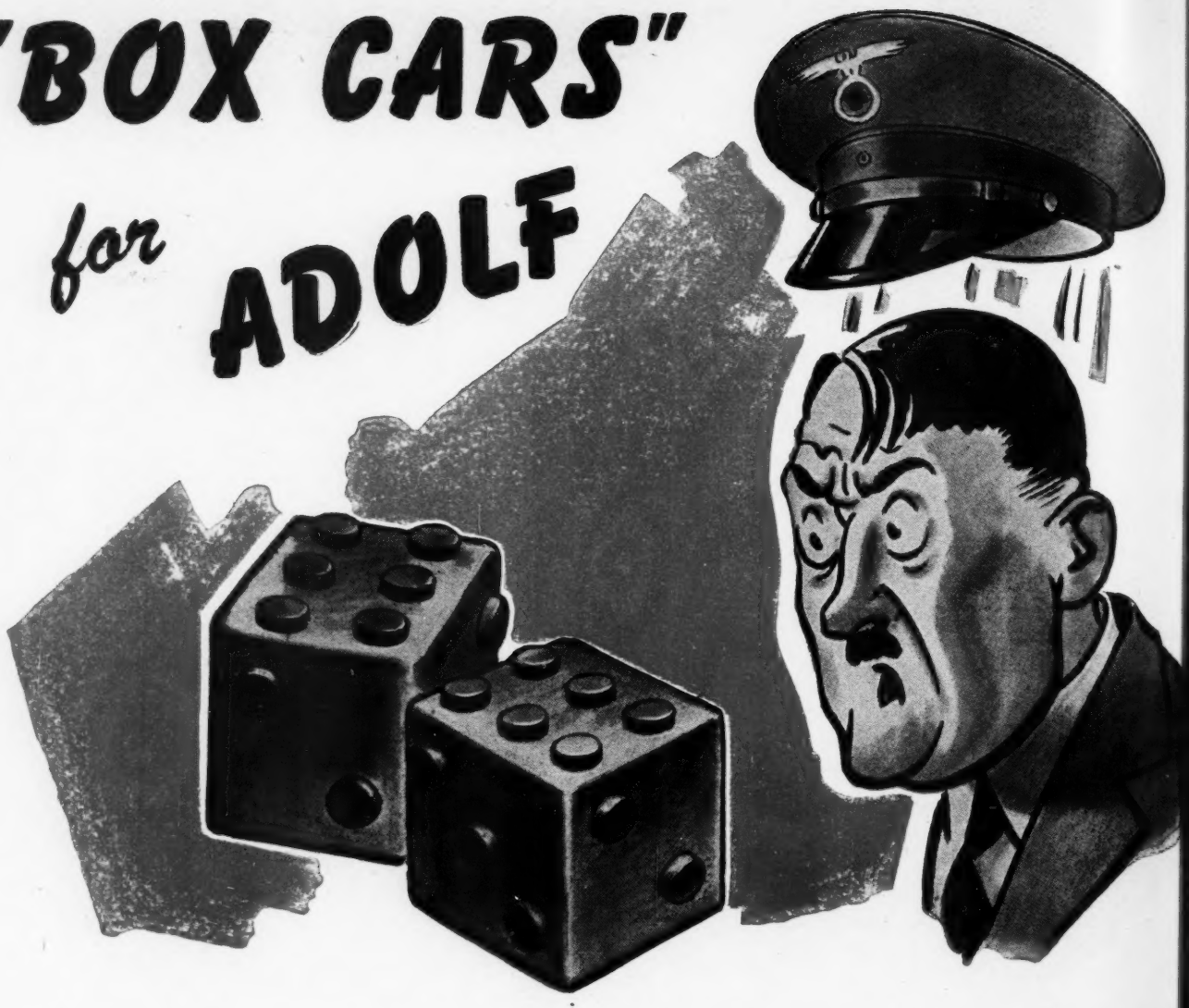
COMPANY.....

ADDRESS.....

CITY..... STATE.....

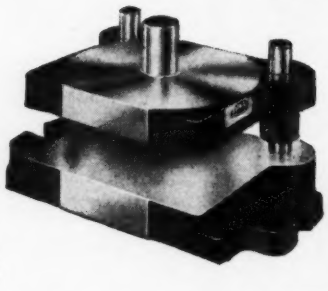
676-86-8940

"BOX CARS" for ADOLF



That odd name came from the shop where strange cubical structures are daily welded and machined. It is known that they are war material, destined to go on to other American workers who will fit them into structures for the defense of America and the defeat of the Axis.

Along with them, and huge weldments for the Navy, move die sets from the size of your hand to the huge six ton slabs of metal that stamp out airplane wings, tank sides, portable air fields; and we know not what, for the defense of America and the defeat of the Axis.



DANLY DIE SETS

Welded Steel Fabrication

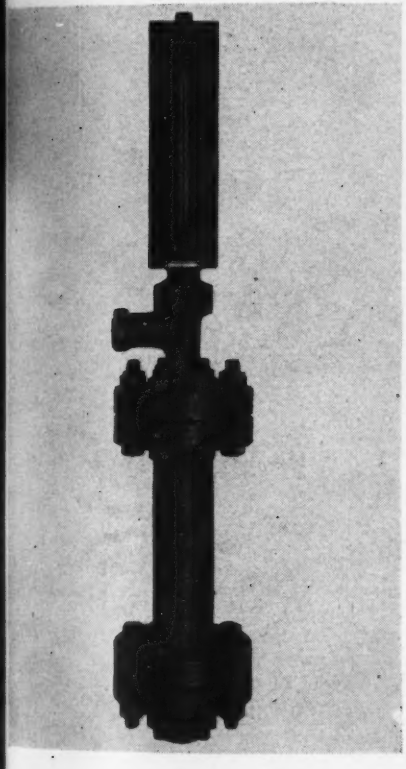
DANLY MACHINE SPECIALTIES, INC., 2100 So. 52nd Ave., Chicago, Illinois

MILWAUKEE • DAYTON • ROCHESTER • LONG ISLAND CITY • DETROIT • CLEVELAND
PHILADELPHIA • • • • • • DUCOMMUN METALS & SUPPLY COMPANY, LOS ANGELES

coil wattage at 12 v. d.c., 3.2; contact pressure, 60 g.; contact capacity, 10 amp. at 30 v. d.c.; temperature rise, 32 deg. C. at 12 v d.c. Priority AA-4 or better. **G-M Laboratories,** Chicago.—AVIATION, *Apr.*, '43.

Hydraulic Rotometer 81

Fischer & Porter Co., Hatboro, Pa., announces high pressure rotometer which automatically compensates for viscosity variations when measuring oil flow rates in aircraft hydraulic systems.



by patented design which creates dead space around float, liquid flow shears upon liquid instead of upon float, and thereby helping eliminate any viscosity drag. Model illustrated measures 2,000 lb.; others are available up to 5,000 lb. Flow rate is read directly on scale.—AVIATION, *Apr.*, '43.

Punching Unit 82

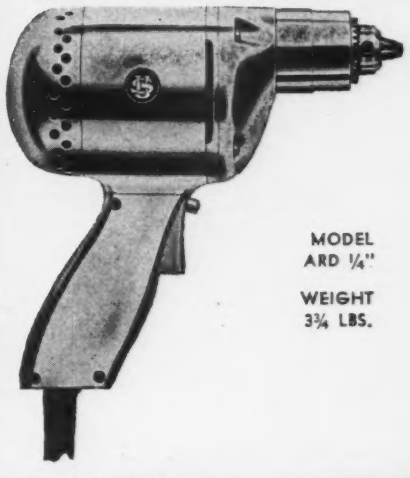
Newest addition to line of Wales punching and notching units, made by **The Strippit Corp,** North Tonawanda, N. Y., is Type "E" hole punching unit for punching series of holes simultaneously in extruded shapes and sections

THE GOOD MECHANIC'S CHOICE!

These little fellows pack a terrific wallop!

UNITED STATES SPECIAL STREAMLINED AVIATION DRILLS

for use in cramped quarters

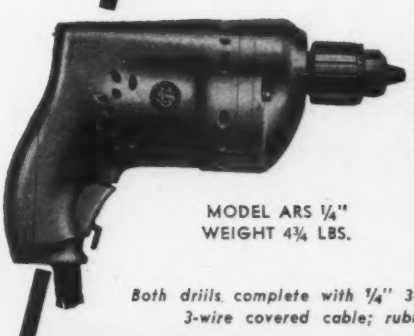


"The biggest midgets in captivity" as P. T. Barnum might have said . . . because these little drills are BIG for power, BIG for speed, though light as a feather and handled as easily as pointing your finger.

Streamlined from bow to stern.

MODEL ARD ¼"

WEIGHT 3¾ LBS.



Universal motor; 750 to 5,000 r.p.m.; ball bearings set in steel retainers; switch with locking pin, center of trigger near end permitting right or left hand use; removable cover on handle for easy replacement.

MODEL ARS ¼"
WEIGHT 4¼ LBS.

Both drills complete with ¼" 3-chuck, screwed on spindle; 3-wire covered cable; rubber attachment plug.

DRILLS . . . DRILL STANDS . . . VALVE SEAT GRINDERS . . . VALVE REFINISHING MACHINES . . . VALVE REFINISHING SHOPS . . . PORTABLE SURFACERS . . . PORTABLE SANDERS . . . FLEXIBLE SHAFT MACHINES . . . LATHE GRINDERS . . . GRINDERS . . . BUFFERS . . . POLISHERS

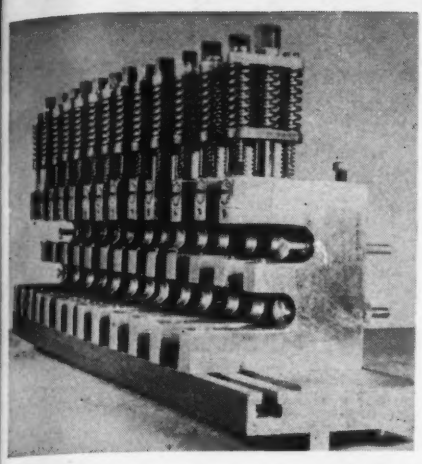
THE UNITED STATES ELECTRICAL TOOL CO.

CINCINNATI, OHIO, U.S.A.

THEY'RE Faster
AND GO FARTHER
American planes today have what it takes! Speed — wider cruising range — greater firepower — maneuverability! All this—due to the ingenuity of aviation engineers and machine tool builders — working with the right kind of tools. That's where Wesson Carbide Cutting Tools are doing their part — *cutting tougher metals, faster, with greater precision, with minimum rejects.* » » » Pioneers in "tooling up" for aviation motor production, Wesson Company is constantly setting new standards of precision and speed in Carbide Cutting Tools.
The counsel of Wesson engineers — skilled in engineering and designing of cutting tools — is available to help solve present war production problems, or for post war planning.
WESSON CO., DETROIT, MICH. (Ferndale Station)
WESSON
Carbide Cutting Tools
First choice when tough metals are to be cut — for special or standard purposes — for single or multiple setups.

WHEN THE WAR IS OVER we'll enjoy higher standards of living here in America. Automobiles, airplanes, tractors and trucks — household appliances — every machine and tool that's made of metal — will be better, safer, stronger.

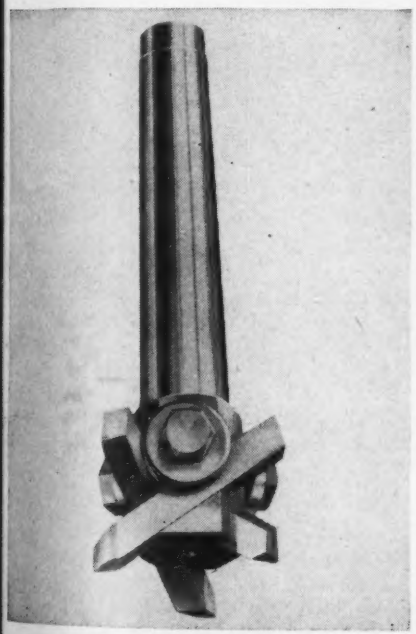
Wesson Carbide Cutting Tools will help to make this possible by cutting *tougher* metals, with greater precision. And these things will cost less to buy — they'll operate more efficiently and more economically — they'll be safer and will last longer.



on press brakes. Each unit consists of punch die, holder, stripping spring, and guide with lower gap below die holder of legs of work. Photo shows series of units mounted on press brake rail.—AVIATION, *Apr.*, '43.

Surface-Facing Tool 83

New surface-facing tool shown here has been designed by **Robert H. Clark Co.**, Los Angeles, to take place of standard end and shell end mills for surface facing. Consists of straight or tapered



shank with three adjustable bits. Set of four tools with measuring gage also provided covers diameters from 1 to 4½ in. Each tool has range of seven or more end mills.—AVIATION, *Apr.*, '43.

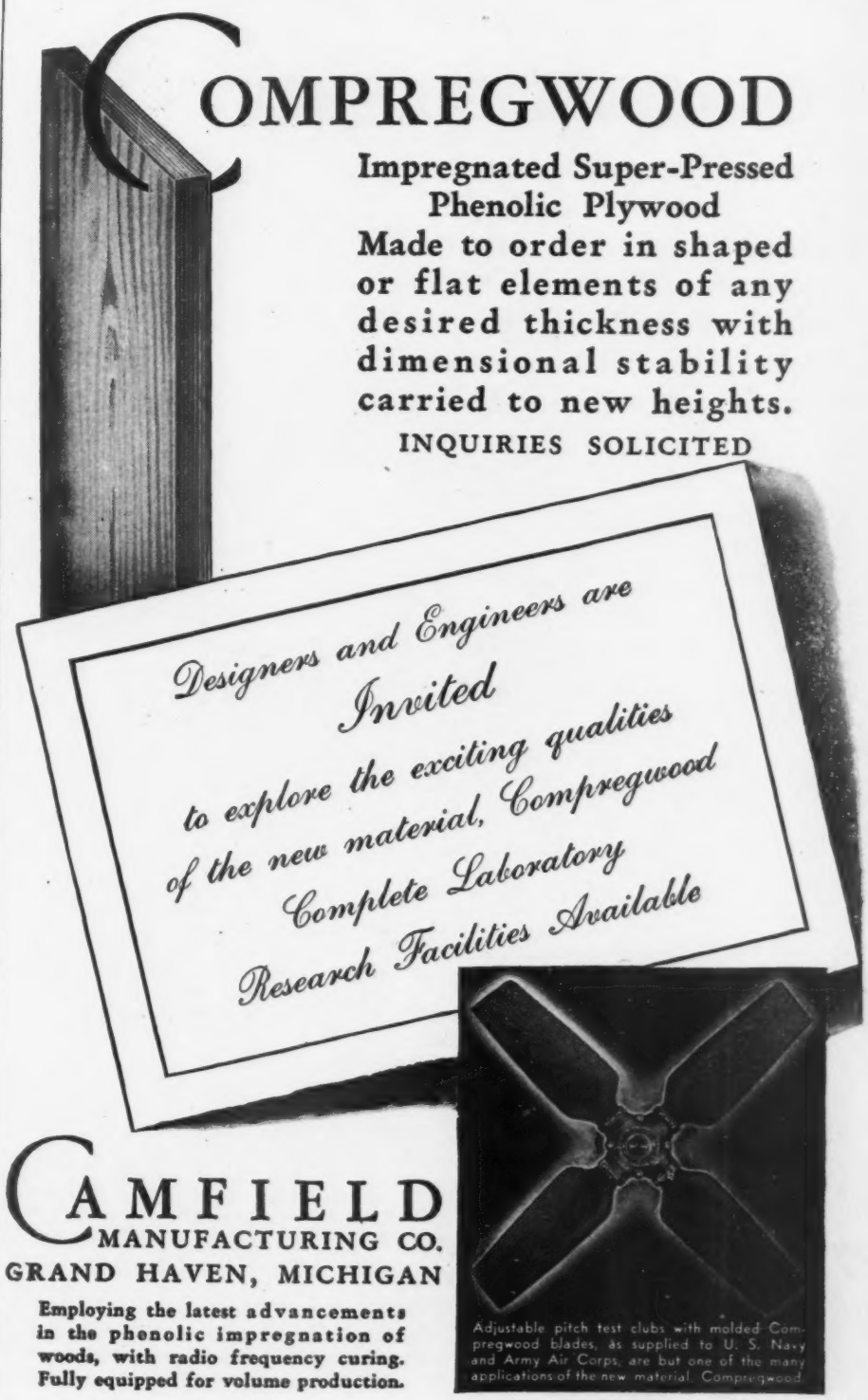
Parachute Yarn 84

With linen and long staple cotton for manufacture of parachute harnesses now critical materials, **United States Rubber Co.**, New York City, has developed substitute material, Ustex. Approved by Wright Field for harnesses, new yarn is produced by chemical and mechanical processes from regular grades of cotton without carding, combing, or twisting. It is said to have increased strength and good resistance to weather and mildew.—AVIATION, *Apr.*, '43.

Portable Elevator 85

In use at Army airport hanger, portable elevator by **Revolvator Co.**, North Bergen, N. J., has extreme lift of 54 ft. via five welded steel sections which telescope into a collapse height of 11 ft. 9 in. Top platform, 54 x 86 in., is

suspended and worked by four roller chains of 6,600-lb. tensile strength hooked to 1½-hp. motor. Metal-encased gears run in continuous oil bath. Base frame 66 in. x 10 ft. which can be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Impregnated Super-Pressed
Phenolic Plywood
Made to order in shaped
or flat elements of any
desired thickness with
dimensional stability
carried to new heights.
INQUIRIES SOLICITED
Designers and Engineers are
Invited
to explore the exciting qualities
of the new material, Compregwood
Complete Laboratory
Research Facilities Available
CAMFIELD
MANUFACTURING CO.
GRAND HAVEN, MICHIGAN
Employing the latest advancements
in the phenolic impregnation of
woods, with radio frequency curing.
Fully equipped for volume production.
Adjustable pitch test clubs with molded Compregwood blades, as supplied to U. S. Navy and Army Air Corps, are but one of the many applications of the new material, Compregwood.

PACKS THE *Punch* WHEN YOU NEED IT

A G-E POWER PACKAGE THAT DRIVES LANDING GEAR, BOMB DOORS, WING FLAPS, AND TAIL WHEELS

Light, Compact, but Plenty Tough
Careful design, fine materials, and rigid tests—all contribute to the building of an electric drive that packs the punch you need—when you need it.

A superior insulating technique makes the winding structure practically indestructible—even under the severest overloads. The finest magnetic materials available are used to make sure that these G-E power packages will deliver top-notch performance under the most adverse conditions.

Complete Unit—Ready to Install
The power package shown consists of an aircraft electric motor with magnetic brake, reduction gears*, and friction clutch. To keep the number of its moving parts to the minimum, each element is reduced to its simplest terms.

To Designers

This line of power packages can be a great help in simplifying your work. Instead of spending hours co-ordinating the devices that make up a drive, specify a G-E power package. Remember too, these drives save man-hours on the assembly line.

When you have a new design under consideration, see the nearest G-E office about the possibility of adapting an available power package to your application. ***General Electric Company, Schenectady, N. Y.***

*Gears designed and manufactured by Pacific Gear Works, Los Angeles, Calif.

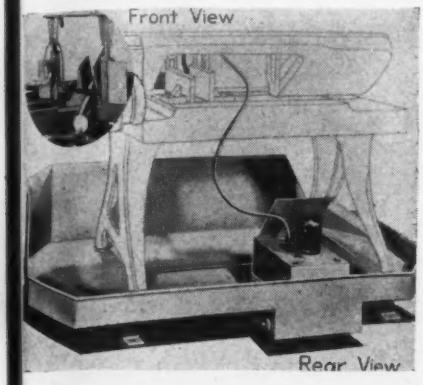
GENERAL ELECTRIC

700-12-8290

steadied by 16-ft. outriggers.—AVIATION, *Apr.*, '43.

Band Saw Cooler **86**

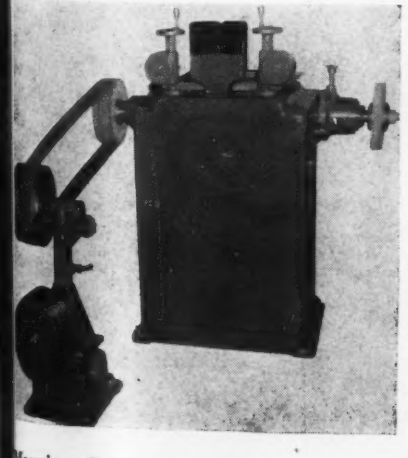
Designed to fit all types of horizontal band saws without alterations, coolant system of **Gray-Mills Co.**, Chicago, consists of pump and coolant return pan



larger and below the blade and guards to protect operator from splashing oil. Special oil to be used with device is specified as "Flo-Bac" Saw-Kut No. 5. —AVIATION, *Apr.*, '43.

Sanding Backstand **87**

Easy conversion of one end of a grinding wheel unit into a belt sander is illustrated by use of Idler Backstand. Work is sanded on abrasive surface of belt, which is manufactured by **Behr-**



Manning Corp., Troy, N. Y. Bench model also available.—AVIATION, *Apr.*, '43.

Engine Mounting **88**

"Rubberflex" is name given by **Bushings, Inc.**, Berkley, Mich., to new line of

Ready for
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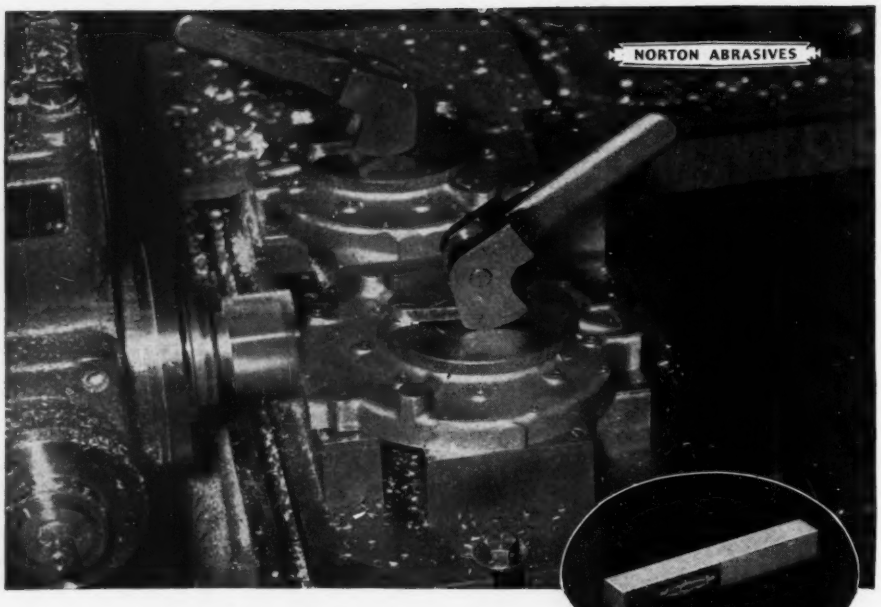
SEE THESE SCIENTIFICALLY
DEVELOPED COMPOUNDS PERFECTED
FOR INDIVIDUAL CLEANING PROBLEMS
Metex
COMPOUNDS FOR ALUMINUM AND ALLOYS — Improved, fast acting precision cleaners individually formulated for special applications. Guaranteed to improve the luster of your product and reduce your operating costs.
Anodex
PROCESS AND COMPOUNDS FOR STEEL — Blast inorganic dirts from ferrous metals with this approved reverse current process and these specially formulated high current density compounds. Fast. Economical. Lower operating cost!
WRITE FOR Free DATA SHEETS
MAC DERMID
INCORPORATED
WATERBURY, CONNECTICUT
Los Angeles
St. Louis
Toronto, Canada
SALES AND SERVICE FROM COAST TO COAST
Chicago
Newark
New York
Cleveland
Detroit
Philadelphia



HAND STONED SHELL MILL GIVES 4 TIMES THE OUTPUT

Hand Stoning **the cutter of this shell end mill resulted in over four times the production of magnesium parts for war work.**

THE JOB: Machining to size, a boss on a magnesium casting. Cut .150 on first side, .250 on the opposite side; 24 hour continuous operation.

THE REPORT: "With regular grinding, 67 parts were machined before failure of the milling cutter. We then stoned the same cutter by hand with a 'Hard Arkansas.' This increased production to 280 parts. High speed production on this metal means that all cutters have to be hand stoned."

The stone used was a "Hard Arkansas" square file 3½ x ½ x ½" costing 70¢, good for years of the same high grade service.

Consider the little effort and cost to speed up and increase output; the scarce tool steel and equally precious setting-up time saved in grinding only one-quarter as often. Multiply that by the number of tool cutters you operate and see what it really means.

You can get further details from your Distributor Salesman or by writing us.

Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New York, Philadelphia, St. Louis, San Francisco, Tacoma

BEHR-MANNING · TROY, N.Y.
(DIVISION OF NORTON COMPANY)
ALSO RELIABLE COATED ABRASIVES SINCE 1872

NEW PRODUCTS

engine mountings composed of full reclaim rubber, Butyl, Thiokol N, or Buna. Placing of cushion between inner and outer wall of steel, stainless steel, bronze, or brass, is announced to save 17 percent of normally required rubber. Held together mechanically, mountings permit only ¼ in. fall should weight shear rubber and thus become solid instead of insulated support.—AVIATION, *Apr.*, '43.

Metal Cutter 89

Fitting chuck of ¼ in. pneumatic or electric drills is Royal Clipper Metal Cutter, produced by Aircraft Tool Division of **C-B Tools**, Lancaster, Pa.

Operator drills ¼ in. hole in sheet to be cut, inserts tongue of cutter which will clip lines and patterns in material up to .040 in.—AVIATION, *Apr.*, '43.

Coil Lifter 90

For lifting coil stock without raising it first, **Never-Slip Safety Clamp Co.**, Mamaroneck, N. Y., has produced me-

chanical device illustrated which is easily attached to any hoist.—AVIATION, *Apr.*, '43.

New Bench Model
Automatic Bucker
For Production Riveting

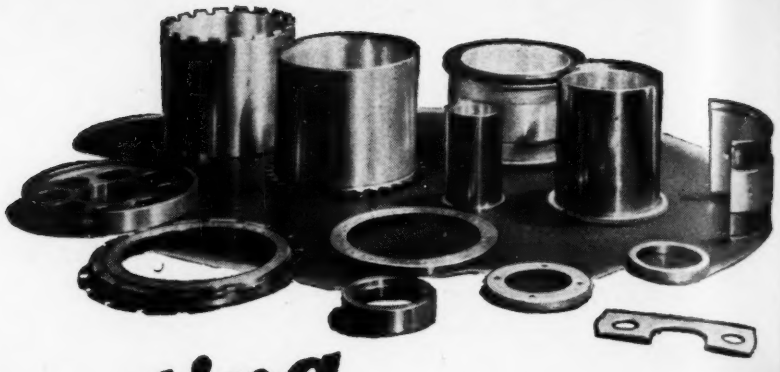
Now one person both bucks and rivets in one operation FASTER, BETTER, EASIER

Another Aero Tool FIRST

SEND FOR BULLETIN ON YOUR FIRM LETTERHEAD

CABLE ADDRESS AERO

AERO TOOL COMPANY • BURBANK, CALIFORNIA



We, Too, Are Accumulating Valuable Experience

Precision Testing—This is a special Mallory-designed fixture for checking each bearing spline with relation to others. Similar inspections at other stages of production control quality of materials, gauge physical dimensions, make certain accuracy.

Experience is providing ever-increasing gains in the output of Mallory Bearings made by the Mallosil Process of bonding rare metals to base metal backings. Experience has made possible a quality and quantity of precision accuracy production considered impossible only a few months ago.

Experience is responsible for the technique that makes Mallory Bearings reliable performers for aviation engines that must withstand terrific pounding and fatigue stresses under the most difficult combat conditions. With tolerances measured in split-thousandths, Mallory Bearings provide tough, homogeneous silver surfaces of high fatigue resistance; ample strength and hardness; and high resistance to seizure. Their War record bespeaks their superiority for the toughest kind of work.

Experience has enabled Mallory to design tools and testing equipment that assure uniform accuracy for Mallosil-processed Mallory bearings, bushings, pinion races, gear races, spacers, collector rings and other vital parts used in many types of military planes.

Of course, all Mallory experience now is concentrated on War production. But continuous research is aiding experience and the net result will be a fund of knowledge invaluable after the War to manufacturers of high-speed motive parts. Consult us.

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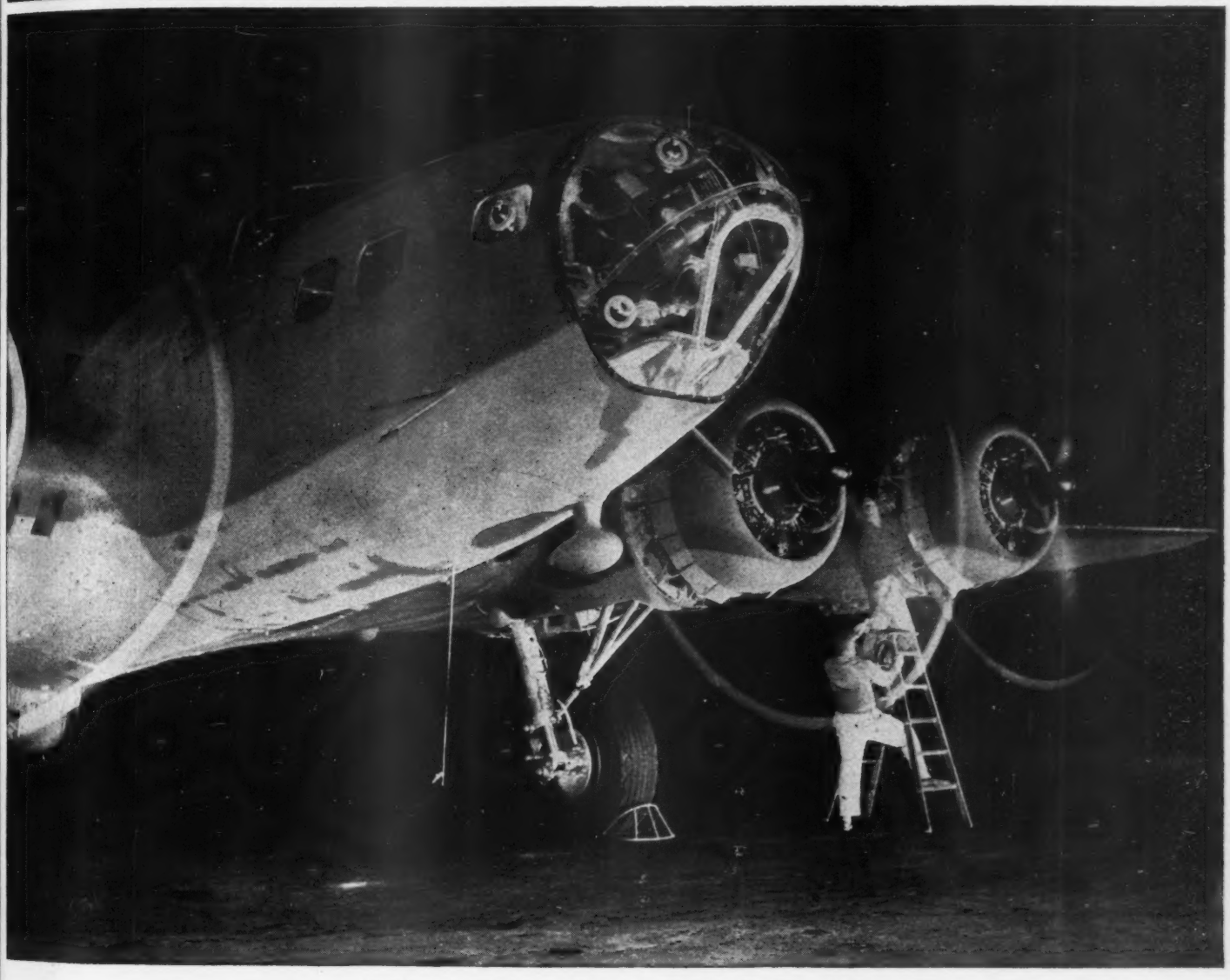
Plexiglas

ON THE FLYING FORTRESS



A Boeing Flying Fortress, built by Vega, warming up at night

THE world's first transparent plastic bomber nose was made of PLEXIGLAS—in a Rohm & Haas plant. It was here that the method for mass production of these curved sections also was developed.

Today you'll find PLEXIGLAS aboard every type of Army and Navy airplane . . . in bomber nose assemblies, tail enclosures, gun turrets, cockpit covers . . . down to the smallest windows and landing light covers.

You see, PLEXIGLAS remains crystal clear indefinitely. It keeps its great strength even at sub-stratosphere temperatures. It's easy to cut and to mold into smooth streamlined shapes. Six years of use aboard every type of aircraft, have earned PLEXIGLAS the title of "America's Standard Transparent Plastic."

ARMY E NAVY

PLEXIGLAS *is the trade mark, Reg. U. S. Pat. Off., for the acrylic resin thermoplastic sheets and rods manufactured by the Rohm & Haas Company*

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UNAFFECTED BY VIBRATION

POSITIVE OPERATION REGARDLESS OF CHANGE OF MOTION OR ACCELERATION

All General Controls hi-g electromagnetic valves have a fundamental and important operating characteristic: valve operation is positive regardless of vibration, change of motion or acceleration, as indicated by increases in the "g" factor.

General Controls hi-g electromagnetic valves are available for many aircraft control applications. The complete line includes gasoline, oil, anti-icing and cabin heater controls; high pressure hydraulic controls, including 3-way and 4-way selector valves; gasoline cross feed and safety shut-off valves; oil dilution valves; proportioning controls, etc.

Fast acting and light in weight, they are designed for various automatic and remote control requirements and are available in normally open or normally closed types, for intermittent or continuous duty, handling gases, fluids, vapors and vapor mixes.

A descriptive Bulletin shows how General Controls hi-g valves can simplify complicated aircraft control systems and at same time make measureable savings in weight, materials, space, installation time and money. Write today for your copy.

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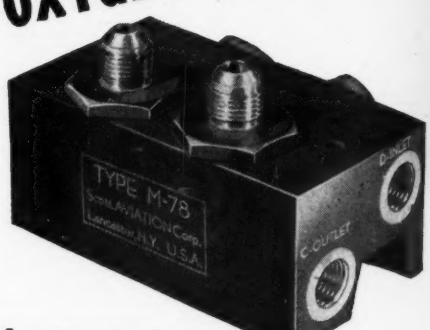
Traveling on his lungs!

. . . guarded by a SCOTT OXYGEN MANIFOLD



A vital component in oxygen systems for high altitude flying

The function of the Scott Oxygen Manifold is to direct the flow of oxygen from an outside source to service tanks, from service tanks to the oxygen regulator or to the other equipment. Guards against the loss of total oxygen supply in event of direct tank hit. Compactly constructed, and weighing only 15 ounces, this Scott-developed unit is designed to serve any number of tanks either centrally located or distributed throughout the ship... In addition to oxygen equipment, Scott aircraft accessories include Brake Pressure Units, Control Wheels, Stabilizer Yokes, Rudder Horns, Aileron Bell Cranks and 40-E Scott-Cast Aluminum Alloy Castings. Your inquiry on special equipment will receive prompt attention.

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AVIATION CORPORATION
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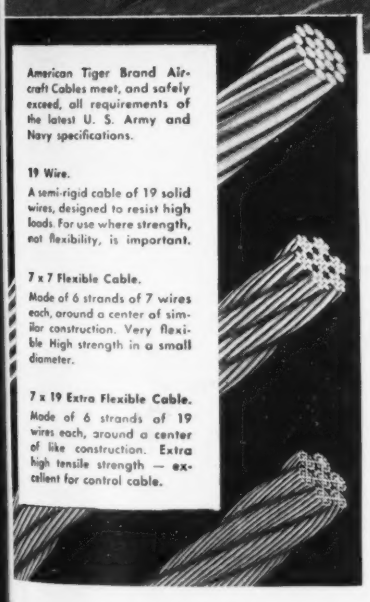
DESIGNERS AND MANUFACTURERS OF SPECIAL EQUIPMENT FOR THE AIRCRAFT INDUSTRY

SUPPLIERS TO THE U. S. ARMY AND NAVY AIR FORCES AND LEADING AIRCRAFT MANUFACTURERS


American Tiger Brand Aircraft Cables meet, and safely exceed, all requirements of the latest U. S. Army and Navy specifications.
19 Wire.
A semi-rigid cable of 19 solid wires, designed to resist high loads. For use where strength, not flexibility, is important.
7 x 7 Flexible Cable.
Made of 6 strands of 7 wires each, around a center of similar construction. Very flexible. High strength in a small diameter.
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BOMBING and strafing at tree-top level—at speeds approaching 500 m.p.h. — this hell-raising fighter gave the Nazis the surprise of their lives when it first appeared on the battle scene.

Because it flies so low and so fast that the human ear can hear it only when it is overhead, only the luckiest shot can bring it down. But, unless the plane controls act instantly to synchronize with the pilot's lightning-quick reflexes, the dangers of a crack-up are great.

It is this kind of instant-acting, dependable control that is assured by American Tiger Brand Aircraft Control Cables. Their in-built qualities of high strength and high fatigue resistance make possible the sensitive, unfailing response indispensable for all precision flying and rapid maneuvering.

In these Control Cables are ideally combined light weight, minimum stretch, high resistance to abrasive wear and superior flexibility. All are of Excellay Preformed construction to insure flawless performance—under every condition of service.

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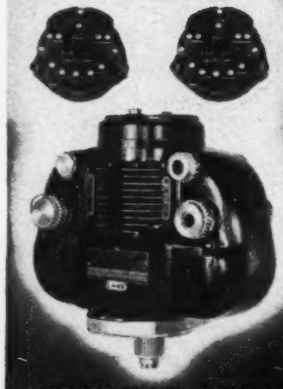
UNITED STATES STEEL

Victory Sparks for "Lightnings"

FLYING HIGH over hot Tunisian sands and steaming New Guinea jungles, American heavy bombers blast enemy bases and docks. And with them fly speedy "Lightnings," that shoot down out of the blue to blast attacking enemy fighters.

For high altitude flight and fast dives, banks and turns, "Lightnings" need rapid fire-power in engines as well as guns. Each second, hundreds of precision-timed sparks must be generated *and delivered* to engine cylinders.

This vital job is performed by "BENDIX-SCINTILLA" Ignition. Constantly improved to meet new conditions of engine power, altitude, and flight, "BENDIX-SCINTILLA" Aircraft Magnetos, Harnesses and Switches fly on well-nigh every modern United Nations' aircraft... vital members of "The Invisible Crew" in action on every front.



"BENDIX-SCINTILLA" Aircraft Magnetos, Harnesses and Switches are vital members of "The Invisible Crew"—precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews everywhere.

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THE WORLD'S FINEST AIRCRAFT IGNITION

THE INVISIBLE CREW
Precision Equipment by Bendix
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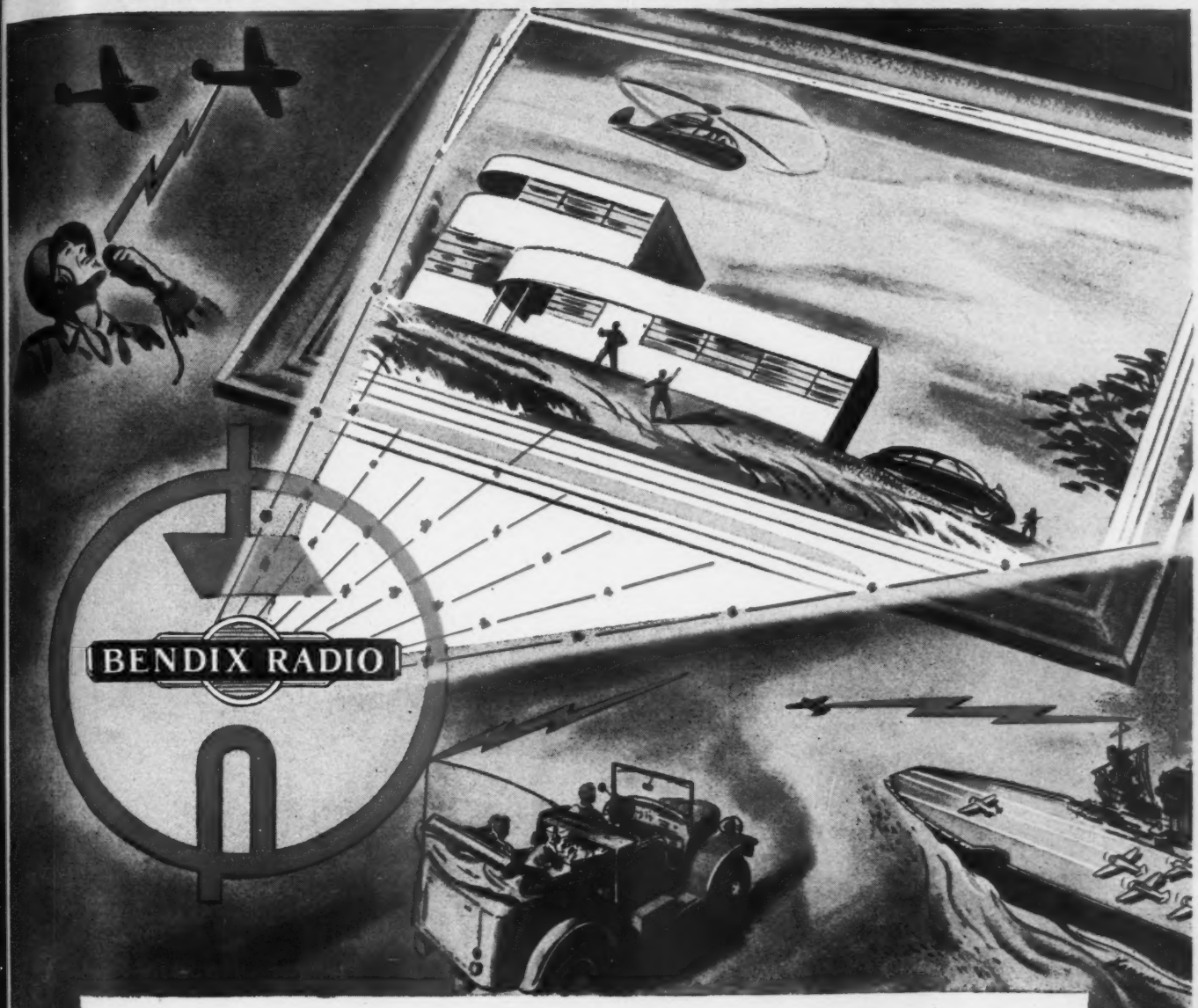
"SCINTILLA" AIRCRAFT MAGNETO



HERE...Electrons at War Frame the Future!

HERE, at Bendix Radio, with each new development in radio communication, radio navigation and radio detection, for the use of our armed forces, electronic discoveries are speeding victory in this war. Just as important, these same discoveries also are throwing fragments in all directions to frame the future. In this future, we see unlimited new fields of endeavor opening up for our fighting men when they return — and for all America. And we realize, as we explore further, that the multiple peacetime applications we envision now, are just the beginning of the new world of electronic marvels we are planning to help build.

Products of Bendix Radio Division are important members of "The Invisible Crew"... precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

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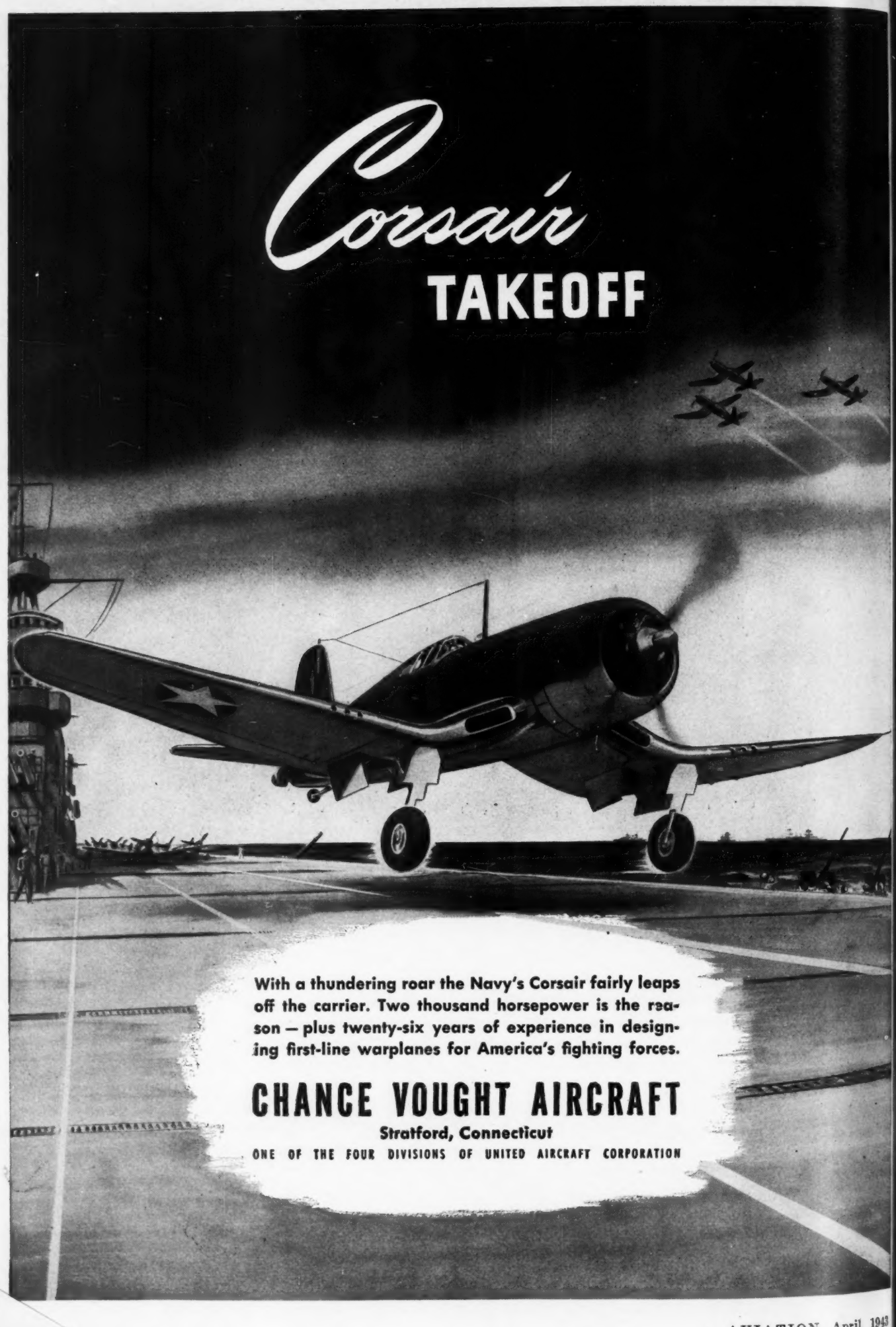

With a thundering roar the Navy's Corsair fairly leaps off the carrier. Two thousand horsepower is the reason — plus twenty-six years of experience in designing first-line warplanes for America's fighting forces.

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Stratford, Connecticut

ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington E. EUGENE MILLER, New York JOHN FOSTER, JR., New York HERB POWELL, New York

Kaiser Buys All Stock in Fleetwings Firm; Also Assumes Chairmanship of Brewster

Henry J. Kaiser, West Coast shipbuilder, has purchased all the stock of Fleetwings, Inc., and has also become chairman of the board of Brewster Aeronautical Corp. He has not, however, acquired stock in the latter concern.

Army-Navy "E" winning Fleetwings has two Pennsylvania plants employing 5,000 workers, and a third plant is under construction. It builds the BT-12, stainless steel basic trainer for the Army, and various subassemblies for other producers.

Mr. Kaiser's assistant, Chad F. Calhoun, has been designated contact officer between the Kaiser Co. and Fleetwings, in which no management or personnel changes are planned.

In becoming chairman of the Brewster board, a move which Rear Adm. S. M. Kraus, of the Bureau of Aeronautics, points out had complete Navy approval, Mr. Kaiser said he thought no personnel changes would be necessary at Brewster. "It is my understanding that there is a high degree of skill in the Brewster organization, and it will be my purpose to coordinate activities in more productive efforts to increase output."

C. A. Van Deusen, former president, submitted his resignation and was succeeded by Frederick Riebel, Jr., formerly in charge of production for Westinghouse, who came out of retirement last summer at the request of the Navy.

Concurrently with Mr. Van Deusen's resignation, a spokesman issued a statement which said in part that "during the last ten months the company had been able to make substantial progress in production for the Allied forces.

"Since this management assumed charge in May, 1942, production increased several hundred percent. The Brewster Newark plant, which has been manufacturing wings for PBY flying boats, is several months ahead of Navy and Consolidated Corp.'s requirements. Management has also renegotiated upward the prices of other than U. S. Government contracts found to be too low in the amount of about $5,500,000.

"Retiring management's decision to stand aside in favor of Mr. Kaiser is based on the belief that Kaiser management might be able to obtain closer support and proper plant facilities from the U. S. Government in plans for making Brewster a strong aircraft producer." Mr Van Deusen is expected to return to the aircraft field after a short rest.

New Brewster board members, besides Mr. Kaiser and Wm. F. Kurtz, F. D. Schnacke, and Capt. George C. Westervelt, holdovers from the old board, include T. J. Walsh, president of the Walsh Construction Co.; Paul S. Marin, chief counsel for the Kaiser interests; E. E. Trefethen, Jr.; and Mr. Riebel.

Affirm Wright's Authority Over Aircraft Resources

Washington (AVIATION Bureau)—T. P. Wright, director of the Aircraft Resources Control Office of the Aircraft Production Board, has been given extensive authority over materials, manpower, machine tools, and other factors affecting the airplane industry.

His powers, now formally legalized, are established in a directive from C. E. Wilson, head of the Aircraft Production Board and vice-chairman of WPB.

Mr. Wright, civilian aeronautical engineer, was vice-president and director of engineering of the Curtiss-Wright Corp. He has been a key man in WPB's aircraft program since 1940 and is likewise a member of the Aircraft Production Board (see organizational chart on p. 111, Feb. AVIATION) which is the policy-making "Little WPB" for aircraft production. (An editorial regarding Mr. Wright and his new powers appears on p. 105 of this issue.)

Other members of the Resources Control Office are Brig. Gen. Bennett C. Myers and Rear Adm. E. M. Pace. The Resources Control Office works out production schedules of airframes, engines, and propellers; serves as a claimant agency under the new CMP (Controlled Materials Plan) which so far allocates only steel, copper, and aluminum; prepares estimates of requirements of materials, tools, and work hours; and coordinates the materials conservation programs of the Army, Navy, and WPB.

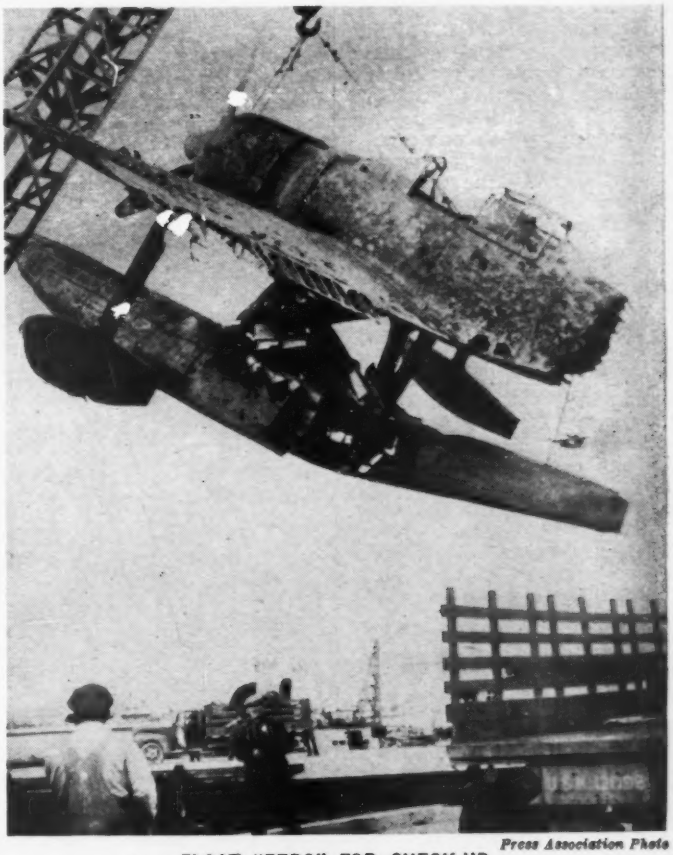
Bendix Radio Research

Los Angeles (AVIATION Bureau)—Establishment of an independent radio and electronic research department which will undertake the development of new radio systems, has been announced here by Bendix Aviation, Ltd. Delmar Wright is director, and assisting in the work will be Dr. Sydney Weinbaum, formerly of the California Institute of Technology staff. Purpose of the new department is to explore advanced uses for radio and electronics.

Bellanca Regains Control

Following his protracted proxy fight, Giuseppe M. Bellanca apparently has regained control of Bellanca Aircraft Corp. through election of four of the seven members of the board of directors, including Andrew J. Higgins, New Orleans boat builder.

However, Lessiter C. Milburn, president, called a directors' meeting when two of the Bellanca selectees were out of town, giving him a three-to-two majority by which he promptly re-elected the management which Mr. Bellanca had opposed.



Press Association Photo

FLOAT "ZERO" FOR CHECK-UP

Shot down in Pacific, this Jap float-type "Zero" is seen being unloaded at Alameda, Calif., prior to examination of its structure by the Navy. Pilot "lost face" and no doubt life. "Zero" lost tail.

New Contracts Between Airlines and REA Approved by CAB; Revisions Detailed

Washington (AVIATION Bureau)—The Civil Aeronautics Board has approved revised contracts of twelve airlines with the Railway Express Agency. The board says that air transportation has reached a stage of development at which it is essential that airlines be freed from certain restrictions so that they can move in any direction the public interest may require.

First, and most important, of four changes in the contracts is release of the airlines from their agreement to maintain air express rates at not less than twice rail express rates. This clause has not made any difference because air rates have been higher than that.

Meanwhile, the clause which forbids the airlines accepting express from any other agency than REA is removed. This does not mean that the airline must handle express directly.

A new clause provides that REA may extend its services on a competing air carrier and cannot be prevented from doing so by another airline.

A provision that REA shall not enter into the air transportation itself is deleted. This clause was unnecessary, since REA could not start a service of its own without a certificate from CAB.

Revision of REA-airline contracts is not a move toward a break up of the two systems, according to CAB and airline spokesmen. Air Cargo, Inc., which was organized months ago by the airlines to survey the whole air cargo outlook, has now gone far enough with its study to know that an airline-owned pickup and delivery system exclusively for air express would cost a prohibitive sum to set up and operate. One major airline executive predicts that the lines will still be working with REA five or six years from now.

The twelve airlines figuring in the contracts are: All-American Aviation, American Airlines, Chicago & Southern, Colonial, Continental, Delta, Eastern, National, Northwest, Penn-Central, United, and Western.

. . . So Anyone Can Do It

Completely automatic flying, making it possible for virtually everyone to fly safely, will be a reality within a few years, according to a prediction of E. R. Breech, president of Bendix Aviation. The 2,500 engineers on the Bendix staff are, he says, making very marked progress in their job of eliminating the element of human error in flying. In discussing Bendix's present role in the war, Mr. Breech states that over 30 percent of the corporation's present war volume of about $60,000,000 per month is in new products which were not on the market prior to the war.

Consolidated "Well Along" On 400-Passenger Craft

Los Angeles (AVIATION Bureau)—That his company is well along on its new giant plane designed to carry 400 persons or an equivalent military load, was reported by Consolidated Aircraft Corp.'s Pres. Harry Woodhead to members of the Society of Automotive Engineers recently in session at San Diego. He estimated that the plane will require four years from conception to birth on the production line but did not state what portion of that period has elapsed.

He predicted that steel will be used more and more in aircraft, and that adjustable jigs and fixtures will be developed which will permit changes in basic models directly on the assembly line. Eventually, he said, it will be possible to manufacture 50 units of one model and then 50 of another on the same line because of rapidly developing flexibility in jigs and fixtures.

The speaker minimized the possibility of converting warplane types to peacetime uses. Such conversions, he held, will be strictly of temporary, stopgap nature, for peacetime aircraft will have to be designed for economy of both construction and operation. The industry will not return to custom-building of planes after the war, he continued, but instead will standardize more and more for greater volume and lower costs.

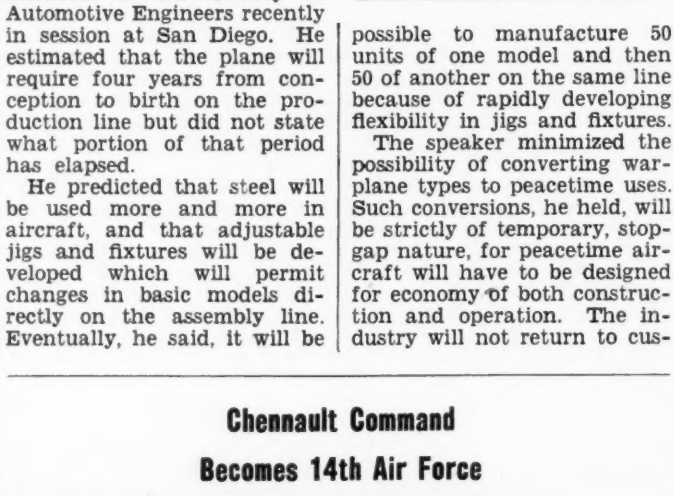
Bismarck Battle Was Pure Air Action

Washington (AVIATION Bureau)—The total destruction of a Japanese convoy of 22 cargo and combat ships aggregating 90,000 tons and about 20,000 Jap soldiers and sailors, plus 55 protecting airplanes in the Bismarck Sea, has been classed by military men here as the most important and decisive purely air action in history thus far.

The months-long engagement between the British RAF and the German Luftwaffe during the blitz was of greater magnitude, but no instance of single action has equalled this complete victory. Allied air forces, including many categories of Army and Navy planes, outclassed the enemy. Jap air coverage of the convoy weakened and dispersed under the attack, and our bombers and torpedo planes—reported to number 136—went in close and unloaded more than 200 tons of missiles on the enemy cruisers, destroyers, and troop ships.

Our losses were relatively light—it is said the Japs lost more ships than we did men. Fact that no airplane carrier was mentioned is the reason for assumption it was purely air operation. Thus this is a sharp lesson in the use of military aviation which will be carefully noted.

Chennault Command Becomes 14th Air Force



Press Association Photo

Word comes that the 14th Air Force has been established in China superseding the former China Air Task Force, and Brig. Gen. Claire L. Chennault (seen here second from left) has assumed its command, stepping up from his leadership of the Task Force. Discussing raid plans with the general are (left to right): Lt. Col. Herbert Morgan, Col. Robert L. Scott, Jr., and Col. William E. Bayse. Chunking reports that Gen. Chennault's new 14th will probably be reinforced for an intensification of the air war.

Air Transport Command Data Reported by Chamber

Our Army Air Transport Command, built on the framework of the old Ferrying Command and the Contract Air Cargo division, now has one route ranging 17,000-mi., and flights of 6,000, 8,000, and 10,000 mi. are considered routine. ATC delivers in a matter of days and hours to Australia, to North Africa, or to Aleutian sectors, plane parts, munitions, and personnel. Surface transport of the same would require weeks or months.

From points throughout the United States, the command lines radiate to Africa, South America, Alaska, Iceland, Hawaii, China, Liberia, New Guinea, Siberia, and the British Isles. Some 130,000 separate items of war materials are flown daily to these points, and many types of goods are ferried back to this country. This data was compiled by the Aero Chamber of Commerce and released by the Army.

Groups of technical experts can be flown to some far-away war zone and be back at their home plants only a week later. Urgently needed plane parts can be set down at some specific frontline airport a day or two after the call for them has been received at the factory of their origin.

ATC equipment includes Douglas DC-2's and DC-3's, Douglas *Skymasters*, *Skytroopers*, and *Skytrains*, Curtiss *Commandos*, Boeing 307 *Stratoliners*, C-87 Consolidated *Liberator Expresses*, cargo versions of the B-24.

Some Boeing B-17 *Flying Fortresses* are also in use on the ferry runs, and Lockheed *Lodestars* are engaged in regular flights. Soon to get into the service are the Lockheed *Constellations*, heavy four-engine cargo ships, and Curtiss *Caravans*.

At one point, a glacier was leveled off to serve as a landing field. This glacier is moving one foot per month, but being figured to last a century or so it may be considered "permanent." At another point workmen were parachuted into a wilderness to hack out enough space so that mechanical clearing devices could later be dropped in sections, by other parachutes, to complete the job.

ATC is still in its infancy. The Army says it will ultimately be ten or more times the size of the combined peacetime airlines of the entire world.

AWPC of West Coast Reports Increases

Los Angeles (AVIATION Bureau)—Deliveries by the eight member companies of the Aircraft War Production Council, Inc., West Coast, increased 240 percent by weight during the first 13 months of war, Council Pres. Robert E. Gross, also president of Lockheed, has announced. Dollar deliveries increased 147 percent to a daily average of more than $5,500,000. Deliveries by weight increased 8.4 percent in November.

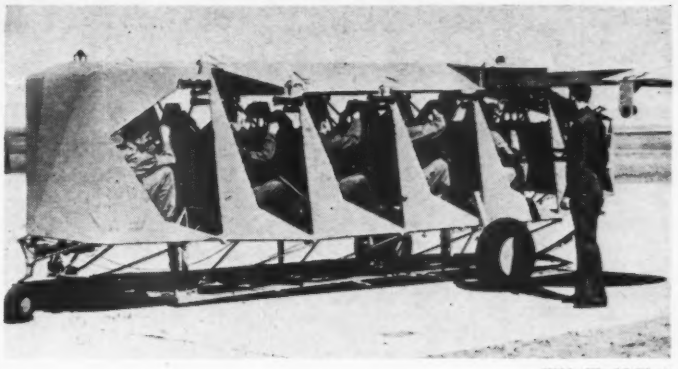
Manhours of the eight companies increased 99 percent during the past 13 months and resulted in an increase of 96 percent in pounds of airplane produced for each manhour worked.

Through the council, 1,734 normally confidential technical engineering reports were interchanged among the member companies and 16,338 emergency exchanges of production items were counted. More than two score instances of machinery breakdown resulted in production work being temporarily done by another plant thus avoiding shutdown. Many exchanges of information and production work were also made by member companies with aircraft plants in other parts of the nation.

Atlantic Flights Zoom

Both Pan American's traffic and the flights of the Army and Navy Air Transport Commands are now reaching phenomenal levels, as many as 500 weekly ATC flights being made, while Panam's traffic increased an average of 140 percent over already-busy 1941. Especially the increase in freight traffic is impressive, rising from a few thousand pounds in the previous year to many millions in 1942.

The Air Transport Command flights are now reaching a level often envisioned by such experts as Grover Loening, and while no actual figures have been made available, a minimum net load of two tons per flight would indicate that airplanes are now carrying 1,000 tons plus per week over the ocean to our far flung battle fronts. Larger and faster aircraft should eventually answer the question whether aircraft can take over part of the seaborne traffic, a question which has been foremost in the minds of many air cargo advocates.



Wide World Photo

GLIDER MECHANICS' "SCHOOLROOM"

In this beetle-like tandem glider mock-up, prospective glider mechanics get practical field instruction in instrument maintenance and repair. Scene is at Air Forces Technical Training Command School, Sheppard Field, Tex.

Okays Synthetic Tires

Synthetic rubber tires have been approved by the CAA for use on commercial airplanes. B. F. Goodrich made extensive tests of synthetic tire construction which were accepted by CAA in making its ruling. Goodrich had previously built initial synthetic tires for automobiles. The announcement was made by J. S. Pedler, manager of the company's aeronautic division.

Soviet Gets 5,600 Craft, Cite P-39, B-25, India Plant

Washington (AVIATION Bureau)—Lend-Lease Administrator Edward R. Stettinius has reported to Congress that the United States and Great Britain together have sent 5,600 planes to Soviet Russia.

Russia's Ambassador in Washington, Maxim Litvinov, praised American fighter planes, notably Bell P-39 *Airacobras*. He told of a regiment in the air force of the Red Army, using only *Airacobras*, which brought down 43 planes during air fights while losing only three.

A Russian aviation unit, using North American B-25 *Mitchell* bombers, took part in 380 combats during January, in difficult weather, without losing a single plane. One result of these raids was the destruction of a railway junction where five trains of Nazi war material, two troop trains, and a number of locomotives were destroyed.

The American Air Force, Mr. Stettinius said, ferries long-range bombers direct to India and uses airfields built by Indian workmen. Ten thousand workmen were employed to build a single airport. One large aircraft corporation in Bangolore, India, managed by Americans, repairs military planes and manufactures gliders. This plant last year repaired more than 400 planes.

U. S. Anti-Sub Command Now Spans Atlantic

The Anti-Submarine Command of our Army Air Forces, organized to take over the coastal patrol functions of the First Bomber Command, has now extended its operations across the Atlantic Ocean.

This command is charged with seeking and destroying enemy submarines, conducting aerial convoying operations at sea, and providing air coverage for coastal shipping. Officers and men of the command have played leading roles in rescue work following torpedoing of ships off the American coast.

The command will now locate and attack enemy submarines in any theatre where they can be detected.

Graduates of the Army Air Forces regular air-crew schools are further trained in special schools for anti-submarine warfare and then assigned to man the anti-sub aircraft.

Industry Organization Policy Shifting; Third Council Proposed; Boeing in Coast Group

Organization of the aircraft industry in this country is undergoing extensive and rapid changes. What may be the ultimate outcome is unpredictable.

The two Aircraft War Production Councils, West Coast and East Coast, have taken over—for the present at least—the major common wartime interests of the industry. And the Aeronautical Chamber of Commerce has emerged from the initial reorganization scrimmage, with James Murray, dean of Washington aircraft representatives and vice-president of Boeing, as Chamber president.

Only the West Coast Council has a Washington office, thus far, the East Coast Council still having its headquarters in New York City. Eastern aircraft producers do not need representation in the Capital as much as do the far-away-Coast people.

Neither of the Councils, however, can speak for the whole industry on any matters. One would stand small chance of being wrong, therefore, in guessing that an overall parent organization, or national council, was being considered.

In addition, the Automotive Council (an association of auto and allied industry firms producing aircraft and parts, weapons, and war equipment) is proposing a Central Aircraft Council. Informed persons said this council was planned chiefly to serve the interest of automobile companies making airplanes or parts thereof, but that "old line" manufacturers would be eligible. The Midwest has only a few pertinent companies that are not either auto firms or branches of airplane builders.

Many men in the industry still believe that when the war ends the airframe, propeller, and engine manufacturers should be re-united in the Aero Chamber of Commerce. For all any one knows, it might turn out that way.

Meantime Boeing Aircraft Co. has joined the West Coast council as an associate member, after cooperating from outside since inception of the council. Boeing is one of those concerns that does not hurry to join organizations, but in this case the company wanted to take full advantage of the exchange of engineering data, especially in view of the fact that Douglas and Vega, both member firms, are making Boeing B-17's. And council members were anxious to have the fullest kind of association with Boeing.

CAA Asks 200 Schools To Train Army Air Cadets

Washington (AVIATION Bureau)—CAA has invited more than 200 of 500 existing flight instruction schools to sign contracts for training Army aviation cadet candidates and elementary and advanced non-combatant Army reservists. About 100 schools are training Navy personnel. Consequently approximately 200 remaining schools may be forced to close for lack of business, according to a CAA spokesman.

Under the new scheme, flight training, coordinated with ground school instruction, will be conducted by the Air Forces. It will consist initially of ten hours dual elementary flight instruction given, as in the past, by CAA contractors.

This is the fourth type of instruction undertaken by CAA War Training Service. Courses for cadets and instructors are being conducted for the Navy besides the present Army non-combatant program.

Term WLB Coast Wage Rates Temporary Solution

The War Labor Board's directives on wages for Boeing Aircraft Co. workers and for Southern California aircraft employees are termed by competent authority as a temporary solution of a difficult problem.

Union leaders accepted the decision with reservations. Unanimous informed opinion was that if John L. Lewis succeeds in getting $2 a day increase for his miners, or even a substantial part of it, the Administration's resistance to wage-price spiralling will be seriously weakened. Not only the Boeing and Southern California unions, but organized labor right across the board will then make new demands.

WLB applied the "Little Steel" 15 percent formula to the Boeing case and found that a 4½c. general hourly increase was in order. The base rate for all Boeing workers except beginners was raised to 82c.

WLB found Southern California workers entitled to no increase to correct maladjustments, because increases totalling more than 15 percent had been granted since Jan. 1, 1941. But under the reclassification plan that was ordered, about 50 percent of the classified workers receive increases of about 7½c. per hour. The basic rate for all except untrained beginners becomes 75c.

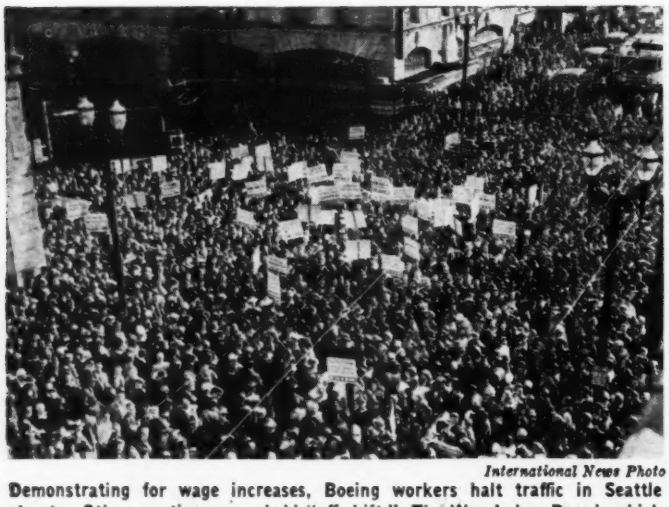
Retroactive pay to July 6, 1942 was ordered for all workers who had been on the payrolls since July 6. This amounted to $64.75 for all California workers and $78.75 for Boeing workers.

Eisemann Control to AEC

Control of the Eisemann Corp., maker of magnetos and generators, has been acquired by American Eastern Corp. Through the merger, Eastern Corp. officials Howard S. Welch and O. H. Ashman, have become president and treasurer, respectively, of the new organization.

Errata

In Feb. AVIATION's American Aircraft Specification table, a typographical error had the high speed of the Fleetwings BT-12 listed as 120 mph., instead of 173 mph. and Footnote 6 incorrectly stated the F4U was being built by Firestone Tire & Rubber Co. This should have read Goodyear Tire & Rubber Co. In the American Engine Specifications table, the make of ignition listed for Air Cooled Motors Corp. should have read Eisemann.



International News Photo

Demonstrating for wage increases, Boeing workers halt traffic in Seattle streets. Other meetings were held "off-shift." The War Labor Board, which ordered the workers to remain "loyally at their jobs" as a condition of considering their request, granted general increase of 4½c. per hour.

★ ★ SPOT CHECKING ★ ★

Production of C-54 *Skymaster* transports has now begun in the new Douglas Chicago-area plant.

According to *Pravda*, Soviet aircraft production during 1942 was 75 percent up from '41.

So many glider pilot candidates have received preliminary instruction that the Army has suspended beginning courses and emphasis is now being placed on advanced work.

Schedule calls for a tripling of P & W bomber engine production in 1943 by the Buick Division of GM in the Chicago area.

King George VI recently made Maj. Gen. Brereton, Middle East commander of all American forces, a Companion of the Order of the Bath. Cited was the General's distinguished service in the Southwest Pacific.

New commander of our heavy bombardment group, 9th Air Force, Africa, is Col. Keith Compton, recipient of the Air Medal and DFC for successful attacks on Italian targets.

Ruling of the WPB permits filing of Form PD-1A for priority assistance with the nearest district office. Applications formerly had to go to Washington.

Resolution to authorize a medal for the President in recognition of his flight to the Casablanca conference has been voted by the Senate. House action had not yet been taken at this writing. Donor of the medal would be the American Section of the International League of Aviators.

With more than 90 percent of its 5,700 employers subscribing for War Bonds, United Air Lines has been awarded the coveted Minute Man flag.

Penn Central is working on special plans to improve air cargo service for the military forces.

A sanitation manual covering air conveyances operating in interstate traffic has been issued by the U. S. Public Health Service.

Plans for national integration of the exchange of aircraft production information have been formulated by the East Coast AWPC, executives of which were preparing to confer with officials of the West Coast AWPC as we go to press.

Congress has been told by Col. Lewis Sanders, chief of the Re-Employment Division, Selective Service, that production time on medium bombers has been cut from 70,000 man-hours to 13,000 man-hours.

As of April 1, planes bearing the CAP emblem are required to display the new CAP registration certificates.

A waterproof radio transmitter which automatically sends an S.O.S. call and code identification has been devised by the Signal Corps for use in planes. The unit is powered by a hand-cranked generator.

For increasing 1942 fourth-quarter production 224 percent in dollar value over third-quarter shipments, the Shefield Corp., Dayton, Ohio, has received a bronze trophy from the National Machine Tool Builders Association.

There are 10-min. rest periods for workers during each shift under a new employee program at North American. Smoking areas and music and news broadcasts are other features.

To tap additional sources of manpower, Douglas is launching a newspaper, radio, and billboard advertising campaign directed toward the Spanish-speaking populace in its vicinity.

Distinguished production service of its employees is now recognized at Scott Aviation Corp. by special awards of wings bearing the Scott emblem.

AC Exhaust Systems

After several months of retooling, Aircraft Components, Inc., Van Nuys, Calif., is now in full production in both its East and West Coast plants, according to Pres. Gilbert G. Budwig, for the manufacture of stainless steel exhaust systems. Included in present production are collector rings, tail pipes, head exchangers, short stacks, and an improved flame dampening short stack is also being made.

Fifth Flat-Top Launched

The *Monterey*, newest of the Navy's aircraft carriers, has been launched at the yard of the New York Shipbuilding Corp. 13½ months after laying of the keel.

AAF Orders Helicopters; Aid to Peace Use Seen

From the Sikorsky Division, United Aircraft, the AAF has now put in an order for 300 of Model XR4 helicopters, understood to be a variation of the Model 300, which has been well known for the past two years. The AAF also has a Platt-LePage helicopter, but there is no report at this writing on its further development.

The military believes that many important missions, such as the rescue of persons from crashes in inaccessible places, spotting and liaison in "bad landing" areas, and the like can be accomplished with these rotary-wing hovering craft. It is believed they can fly telephone wire over impassable ground, and enable more careful aero-study of topography.

Igor Sikorsky, designer, recently predicted the production of hundreds of thousands of direct-lift machines in the early years following the war and at the price of an auto in the medium range. This development by the Air Forces during the war should substantially advance the development of a model for popular use.

Memorial Honors Allen

In memory of Eddie Allen, the new high-speed wind tunnel and research laboratory now nearing completion at Boeing's Washington plant will be named the Edmund T. Allen Memorial Aeronautical Laboratories.

The wind tunnel is expected to be in service by mid-summer. It and the laboratories "were planned and developed under Allen's supervision as Boeing director of flight and aerodynamics, and they incorporate many of his personal ideals and plans," according to P. G. Johnson, company president. "They will provide an outstanding, modern research center in which his staff will carry on the Allen system of painstaking research and development work." (Also see article, p. 108.)

Aero Chamber Officers Named; Murray President

James P. Murray, vice-president of Boeing, has been elected president of the Aeronautical Chamber of Commerce of America, and I. H. Taylor, of Washington, D. C., general manager. Three new vice-presidents are J. Carlton Ward, Jr., president Fairchild Engine & Airplanes: C. S. Jones, president of Casey Jones School of Aeronautics; and J. Story Smith, vice-president of Jacobs Aircraft Engine. New secretary is Frank N. Fleming, assistant secretary and Washington representative of Douglas. John E. P. Morgan, Washington representative of a group of light plane makers, has been chosen as treasurer.

Among those elected to the Chamber's executive committee were J. A. B. Smith, Curtiss-Wright, chairman; Frederick R. Neely, Bell; John K. Montgomery, Consolidated; Carl Friedlander, Aeronca; Joseph T. Hartson, Glenn L. Martin; L. T. Cohu, Northrop; and Charles Marcus, Bendix.

Besides the above, the fol-

SUPERVISORS OF SUPER-PLANES

Seen here studying plans of new research laboratory being built by Curtiss-Wright at Buffalo for design and development of super planes for war and coming peace are (seated left to right) Dr. Norton Moore, chief of aerodynamics research and co-designer of laboratory's $2,100,000 wind tunnel; Dr. C. C. Furnas, formerly of Yale and now laboratory director; and W. E. Voisinet, laboratory manager. Standing (left to right): C. G. Trimbach, assistant chief of developments; E. S. Jenkins, chief of materials and structures; and Peter F. Rossman, chief of developments department.

The Washington Windsock

By BLAINE STUBBLEFIELD

Soap and medicine ad writers soon will sicken everybody of gremlins. However, before they do, we want one last word: Nearly all medieval peoples imagined some sort of little men who interfered with war, hunting, love, and the churning of butter. But moderns don't bother with sprites. If you have a gremlin in your life, blame the British Press Service.

New trick is being considered by the Army Air Forces: Put new pilots in new type planes and they won't find anything to gripe about. It's changing from one thing to another that bothers most people—even young ones.

As the Allies gain superiority in the air, it makes less and less difference whether we have a lot of high-flying equipment, because we ourselves will decide increasingly at what altitude the fighting will take place. This is a generality, of course, to which there are exceptions. For example, we shall always need high level interception to prevent any bombing missions from passing over our forces.

If you are interested in a bit of authentic gossip: The P-38 is Gen. Echols' pet plane, and the B-29 is the favorite of Gen. Arnold.

Grounded crews in the Southwest Pacific theater are actually asking permission to go on forays against the Japs, so lightly do they regard the risk of battling them in the air.

United Nations were scheduled, at this writing, to send representatives to discuss postwar problems with Acting Secretary of State Sumner Welles. The problem of allocation of the air routes among the nations will be a leading matter of discussion. An international corporation to operate all world airways has been proposed, but its chances seem small.

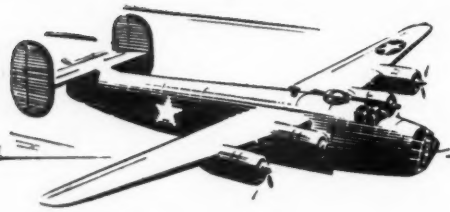
It is true that some airmail is being taken off of some trips to make room for priority passengers, but there is no over-all information as to how much. Neither do authorities know whether the displaced mail gets on another air trip in a short time, or whether it goes by train. Army's Airline Priorities office has no power to establish preferences for anything that does not relate to the war. Of course much airmail does, but it is a problem how to find out *which* mail.

A merry-go-round has been started which is giving the aircraft plants a dizzy ride. Airplane producers were told to hurry up and hire and train a lot of women to take the place of men workers. Now the girls are running away in droves to join WAVES, WAACS, SPARS, etc.

Automatic flying will be the fashion after the war. The Army and Navy have several ways of sitting a plane on a beam without necessity of the airman doing anything. You can even slide down the glide path and land automatically. Word also comes of development of new ways to counteracting drift.

"Spitfires" have appeared in the Southwest Pacific theater in substantial numbers. These excellent short-range fighters apparently are flying guard over Allied bases, relieving American and British long-range fighters for convoy and distant-attack work.

A six-engined transport plane capable of carrying 130 soldiers, has been developed by the Germans—the Messerschmitt 323. Among its reported features is a multi-wheeled undercarriage for landings on rough ground. But our Army's foreign-plane experts here say it will take the Nazis two years to get this ship into the air in quantity. And by that time they . . . well, they may not need it.



98%

of America's Airplanes and/or Engines

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Actus Hose Clamps

The Modern Aviation Hose Clamp

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WrapLock

America's Most Efficient "Strip" Clamp

LIGHTEST in Weight

QUICKEST in Assembly

STRONGEST in Service

Actus Hose Clamps and WrapLock are fighting all over the World

lowing men were elected to the Chamber's Board of Governors, which was reduced from 32 to 15 members at a special meeting on Feb. 18: Rudolph H. Deetjen, Lycoming Division of The Aviation Corp.; Pres. Murray; Sec. Fleming; Vice-Pres. Ward and Vice-Pres. Jones; A. T. Burton, North American; H. W. Cohu, Northrop; Thomas A. Morgan, Sperry; and Raycroft Walsh, United Aircraft.

Calling Names

Arveda Hewlett, still holder of the record as world's youngest feminine parachutist, won at 15, is now an aircraft mechanic at Brewster Aeronautical.

TWA announces changes in its operations department: **Lee Flanagin** has been appointed assistant operations manager in charge of contract air cargo; **H. B. Andrews** is now superintendent of the western division, and **G. T. Weaver,** supervisor of central flight control, has assumed supervision over all of the K. C. flight control office.

John W. Horner, experimental research engineer, has joined the development staff of Guiberson Diesel Engine.

Joan Denton, UAL stewardess, is "in the army now." She left company to join an air evacuation unit of AAF. United also announces following changes: **Paul Henderson, Jr.,** leaves Chicago for Washington as area manager for air cargo department; **Fred F. Dawson** becomes area manager at San Francisco, succeeding his brother, **T. E. Dawson,** who becomes manager of passenger service at Denver; **R. C. F. Baer** is new superintendent of reservations service for company's entire system as successor to **John P. Cisler,** who transfers to work analysis department; **H. K. Cary** becomes eastern superintendent of reservations service; **C. C. Robinson** becomes western superintendent of station service in San Francisco; **Robley L. Mangold** is appointed area manager for Oregon and Idaho; and **Robert Caskey** and **Robert M. Ruddick** are temporarily assigned area managers for Chicago.

Russell J. Smith is named new system manager of reservations for Western Air Lines, and **Rex Aber** is L. A. manager of reservations. **J. W. Carleville** has been appointed assistant to Pres. William A. Coulter.

Sidney A. Stewart has been elected vice-president of United Aircraft Corp.; **C. J. McCarthy,** also elected vice-president, relinquishes his duties as general manager of Vought Division of United and will have general supervision over airplane activities; **J. Reed Miller,** vice-president, was elected general manager of the Sikorsky Division, and **Joseph M. Barr** was appointed assistant general manager; **Rex B. Beisel** was named acting general manager of Vought Division, but retains his present position of engineering manager.

Ralph R. Kimes, former Douglas purchasing agent, has been named general manager of Aircraft Tools, Inc.

W. A. Patterson, president of United Air Lines, has been elected to membership on the advisory board of the Institute of the Aeronautical Sciences.

Thomas D. Brooks has been appointed general superintendent of Chicago & Southern's modification center, and **W. C. Burks** has been named traffic manager for Illinois and surrounding territory.

Lincoln R. Scafe, vice-president and general manager of the Glenn L. Martin Nebraska Co. will return to Baltimore, and **T. Tom Willey,** former Baltimore inspection manager, will succeed him in Nebraska.

Larry Therkelsen, formerly sales manager for Columbia Aircraft Industries, is now vice-president in charge of sales for Westcraft, Inc.

Harry Pack, industrial designer, has been named chief of Pennsylvania Central's newly created Air Cargo Development department.

Andrew H. Phelps, vice-president in charge of purchases and traffic for the Westinghouse Electric & Mfg. Co., recently received the Westinghouse Order of Merit for exceptional service to electrical industry and his company in wartime. Before joining Westinghouse in 1937, he was sales manager and public relations director of McGraw-Hill Publishing Co.

Edward E. Slattery, Jr., is new chief of public information with Civil Aeronautics Board.

W. G. Paton of Cleveland and **W. R. Engstrom** of Seattle have been made vice-presidents of The Austin Co.

Arthur A. Turton is named new chief engineer of Harvill Corp. He has been in charge of company research for past year.

Paul P. Johnson is new manager of aircraft accessories division of Thompson Products, and **Donald E. Beaton** has been named general superintendent.

W. E. Hirtensteiner is named executive vice-president of Interstate Aircraft & Engineering, and **Walter A. Hite,** vice-president in charge of engineering has been elected to board of directors. Interstate also announces election of **Lawrence J. Lay** to newly-created post of vice-president in charge of El Segundo Division; **Lawrence A. Kavanagh,** formerly contract administrator, becomes executive assistant; **F. L. Holser,** formerly staff assistant, has been made plant manager of the Wilshire division; and **W. E. Arrain** has been promoted from superintendent in charge of aircraft to factory manager of Illinois division. Latter is being replaced by **M. E. Landry,** while **C. W. Burst** will remain general manager of Illinois Division.

Joseph Bergin assumes directorship of Utah State Aeronautics Commission, and **John S. Evans** is now chairman of newly created Engineering Commission.

Lessiter C. Milburn is elected president and member of executive committee of Bellanca Air-

craft; **Willard R. Yarnall** succeeds him as vice-president.

Joseph D. Stites is appointed manager of Wickwire Spencer Aviation Corp., new subsidiary of Wickwire Spencer Steel Co.

Jack Sandler joins Aircraft Parts Development to direct aircraft plastics work.

Luther Anderson, is appointed assistant to president of Garrett Corp. and will coordinate activities of AiResearch Mfg. Airsupply Co. and Garrett Supply Co., its divisions.

Dr. Howard Barlow, head of aeronautical engineering department at Texas A&M College, has been elected national Chairman of Society of Aeronautical Weight Engineers; **James B. Childers,** of Globe Aircraft, and **William O. Boyd,** of Lockheed, were elected officers of society.

H. A. Loughran, passive defense director of Brewster Aeronautical, was unanimously elected chairman of L. I. Aircraft Security Conference, succeeding **Jack Fogarty.**

John C. Collins has resigned as vice-president and treasurer of Mid-Continent Airlines to go on active duty as a lieutenant (j.g.) in U. S. Naval Aviation Reserve. Mid-Continent also announces following elections: **J. A. Cunningham** as vice-president in charge military transport division; **C. A. Wicks,** secretary - treasurer; **Martha Knecht,** asst. secretary & asst. treasurer.

Webb Shadle becomes new general council of Civil Aernoutics Administration.

Mrs. Elva Wilson is proud winner of Aeronca's Gold Medallion, won in company's recent Victory Awards Contest for her time-saving idea.

Thomas Lum, Chinese high school student of Honolulu, built 50 model planes for the Navy in connection with its 500,000 model plane construction program, thus became an "Admiral".

Pvt. Walter Hancock, Army Medical Corps, received $1,550 for his winning design for new Air Medal. Odd $50 was his regular pay.

Oswald Ryan has been reappointed to CAB as a board member for six-year term beginning Jan. 1, 1943.

Capt. Glenn Doolittle has recently been appointed chief pilot of Chicago and Southern's Military Transport Division. He is a cousin of Maj. Gen. "Jimmie" Doolittle.

W. F. Jacobs joins Fleetwings as factory manager, and **W. C. Young** joins firm's contract department.

Carl J. Meister has been appointed manager of sales for Atlas Metal Stamping and Atlas Tool & Designing companies.

Dr. George W. Lewis has been elected chairman of Collier Trophy Award Committee.

J. Raymond Bell, former Loews Theater advertising and publicity director, has been appointed director of advertising and Public relations for Pennsylvania-Central.

Curtis H. Barker, Jr., General Electric materials handling expert, has been granted leave of absence to join Navy a technical consultant in its Supply Corps.

W. J. Dalby has been appointed traffic manager of Trans-Canada Air Lines.

UAL's Chief Stewardess **Bernice Caldwell** announces her marriage to **Lt. John A. McFadden,** a United pilot now on leave with Navy.

A. W. Herrington has been elected a director of Army Ordnance Assn.

Donald M. Berges, formerly chief field engineer for Eclipse Aviation has joined Pump Engineering Service Corp., where he will serve in a special engineering capacity.

Samuel S. Bradley was re-elected chairman of board of Manufacturers Aircraft Assn., which administers patent cross-licensing agreement for airplane industry in this country. **Frank H. Russell** continues as president and **John A. Sanborn** as general manager. Following vice-presidents were elected: **Edgar N. Gott,** Consolidated; **R. E. Gross,** Lockheed; **Joseph T. Hartson,** Glenn L. Martin; **J. H. Kindelberger,** North American; **John M. Rogers,** Douglas; **William E. Valk,** Curtiss-Wright; **Eugene E. Wilson,** United Aircraft.

PRODUCTION-BATTLE CITATIONS

A second white star, signifying twelve months' continuation of the production excellence which won an Army-Navy "E" pennant, has been awarded to:

Edward G. Budd Mfg. Co.
P. R. Mallory & Co., Inc.

Single white stars for six months' continued excellence now have been added on the Army-Navy production flags flown by:

Boeing Aircraft Co. (Washington)
S. F. Bowser & Co.
The Bullard Co.
Greenfield Tap & Die Corp.
Handy & Harman
Mahony-Troast Const. Co.
Western Electric Co.

More manufacturers awarded "E" pennants are:
Aircraft Accessories Corp.
Butler Mfg. Co.
Caterpillar Tractor Co.
Edison-Splitdorf Corp.
Electronic Laboratories
A. D. Ellis Mills
Fleetwings, Inc. (Plant 1)
B. F. Goodrich Co., Koroseal Plant
Illinois Gear & Machine Co.
Lindberg Engineering Co.
Michigan Seamless Tube Co.
Pump Engineering Service Corp.
Silent Hoist Winch & Crane Co.
Western Gear Works
Wittek Mfg. Co.

Proposed Air Committee Defeated in House Vote

Washington (AVIATION Bureau)—A resolution by Rep. Jack Nichols, aviation specialist in the House and chairman of a committee which has been investigating air accidents, to set up a standing aviation committee, has been defeated by a vote of 256 to 142. Creation of the committee was part of House Republican Leader Joe Martin's program. Defeat of it cheered opposition elements in the Interstate and Foreign Commerce and Naval and Military Affairs committes. About 50 Republicans joined the opposition to the resolution.

Aviation matters will continue to be handled by the Interstate and Foreign Commerce Committee. Some political observers said the conservatives had hoped, by setting up the aviation committee, to gain control of vast civil aviation activities expected when peace comes. Nichols apparently contributed to his own defeat when he said that the revised Civil Aeronautics Act, now before the Commerce Committee, favors the railroads against the airlines. CAB spokesmen say it certainly does not.

All commentators agree that this is only the beginning of a long fight for jurisdiction over aviation. A proposal to create an Aviation Department under the Executive is expected before the war ends.

New Aviation Fuel Processes Announced

Two new catalytic processes for increased production of aviation fuel have been announced.

Developed by Socony-Vacuum Oil Co. is a translucent, extremely hard but porous spherical particle called "bead catalyst," because of its resemblance to a bead, which is said to give supercharged engines 23 to 35 percent more power, meanwhile increasing fuel base stock yields 13 to 30 percent. This latter result is said to come from the fact that the bead has a longer life than clay or usual fluid catalysts. The new process is called Thermofor catalytic cracking.

Construction by Phillips Petroleum Co. of a large unit employing another catalytic process, Cycloversion, has been approved by the Petroleum Administration for War. Capacity and location of the unit have not been announced, but Frank Phillips, chairman of the company, said that the plant "will convert automobile gasoline or other petroleum distillates into products which, when blended with other components, will impart greatly improved flight performance to finished aviation fuels."

"VENTURAS" GET SET FOR FRONT

In operation five days after authorization, Lockheed and Vega's Texas modification center has grown to four hangars, shops and office, warehouse, and flight operations buildings. "And the end of the expansion is not yet in sight," says Base Manager Don Marshall. Here Vega B-34 "Venturas" pause for last minute grooming and check-up before delivery to the Army for work at the front.

LONG LIFE ASSURED!

The single most important quality you seek in any condenser is...*a guarantee of long life.*

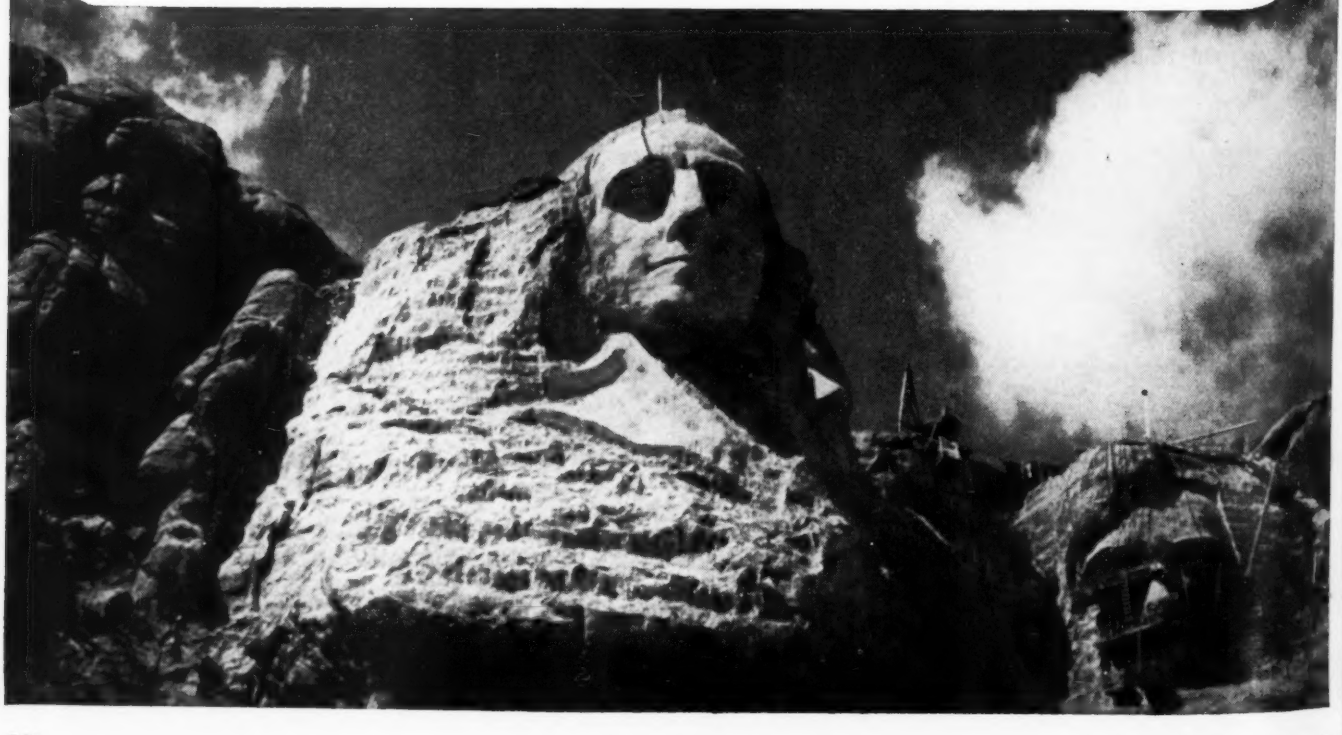
And this guarantee is built into Tobe Capacitors—built in by persistence in research, soundness in engineering, excellence in production, *plus* 20 years of condenser experience.

One of the Tobe Capacitors is Type SIC-510M-6 illustrated above. It is doing a vital war job as a filter condenser in secret equipment. Impregnated and filled with mineral oil, it is typical of the careful manufacture and conservative rating which characterize Tobe Capacitors. Ask us about *your* condenser problems.

TOBE CAPACITOR—TYPE SIC-510M-6-EU

CAPACITY . . . 3 x .2 mfd.
TEST VOLTAGE . . . 8,000 volts DC
WORKING VOLTAGE . . . 4,000 volts DC
SHUNT RESISTANCE . . . 15,000 megohms or greater
POWER FACTOR . . . At 1,000 cycles—less than .004
MINERAL OIL IMPREGNATED—MINERAL OIL FILLED

A SMALL PART IN VICTORY TODAY • TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS • A BIG PART IN INDUSTRY TOMORROW



Truman Committee Checks on Production, Absenteeism, and Skill-Shortage Problems

Shortage of skilled workers has finally brought inevitable production difficulties to some aircraft producers. And, just as inevitably, Congress has "taken a look," seeking defections on the job. Sen. Truman's War Investigating Committee cites many troubles, a few due to mismanagement, but mostly due to scarcity of materials and services caused by war pressure.

Truman's committee emphasized from the first that it was not seeking to badger anybody but simply wanted to find out what the manufacturers' troubles were and try to offer some help. Manufacturers received the committee at their plants accordingly, told them and showed them everything, submitted detailed data, and testified at hearings in Washington.

The committee planned to visit still more plants, might keep it up for the duration. But at this writing the members—seeming to feel that they have discovered most of the things which are wrong—were engaged in writing an aircraft production report, which may be ready about the time this story reaches you.

Though the committee was critical of three or four plants, there was no disposition to ask the Commander in Chief to seize and operate them, which has happened twice before in this war, once because of alleged inefficient management.

As for the Congressmen visiting the plants (everybody knows that only an experienced production man can tell much merely by looking)—the committeemen had to get most of their information by asking informed persons. But they could and did sense prevailing moral and worker-management relations in the plants. Worker absenteeism and lack of skilled plant foremen and superintendents were marked as two specific thorns. As regards these two:

Many remedies for absenteeism have been proposed—penalizing of absentees, rewards for good attendance, provision of recreation to reduce drinking, keeping stores open for night shopping, better diets for health, better and more convenient housing facilities and transportation facilities, baby care for mother-workers, and others. (Also see article on p. 116). If these remedies do not work, willful absentees will soon find themselves faced by a "work or fight" law or an order from the President.

The shortage of skilled foremen and department leaders of all kinds is caused, of course, by the departure of men to the services. There just aren't enough skilled men left to serve as a training nucleus and to watch over the unskilled multitude of men and women. No answer is in sight. Both Army and Navy are determined to take millions of more men. And while taking the men, they will demand that high quality airplanes roll from plants in unprecedented numbers.

It sounds hard, and it is. But the Army, Navy, and Congress have at least one unbeatable argument in their favor: A good many airplane producers, despite all their troubles, are running on or ahead of their schedules. Therefore, if some lag behind, the government wants to know the reasons, and it seems determined that the reasons must be good.

ACWP Manpower Body

Formation of a manpower utilization committee headed by C. E. Wilson, president of General Motors, is announced by the Automotive Council for War Production. Member firms are active in warplane and aero engine production.

Says Council Pres. Alvin Macauley: "Companies which have developed and proved methods for handling such problems as absenteeism, training, transportation, health and safety, employment of women workers, improved production schedules, etc., will share the benefit of their experience with all other companies in the industry."

Alloy Aircraft Steel Section Set Up by WPB

Washington (AVIATION Bureau)—An Aircraft Alloy Steel Section has been set up in the Steel Division of the War Production Board to help speed deliveries of certain alloy items to aircraft plants.

Headed by Louis E. Creighton, formerly vice-president of the Rotary Electric Steel Co., Detroit, and for many years an operating executive of the Union Draw Steel Co., the new section will handle problems relating to aircraft alloy steel requirements.

Study of the aircraft alloy situation has just been completed by the Steel Division in collaboration with the Aircraft Scheduling Unit and with metallurgical, production, distribution, and statistical experts from the steel industry.

11,000 NAA Trainers

Announcement was made in mid-February that more than 11,000 planes have been built in North American Aviation's trainer series, 10,000 by NAA plants in the United States and better than 1,000 by Noorduyn Aviation, Ltd., of Canada. Planes of the series produced for the British have been known as *Harvards*. On Jan. 4, 1943 the War and Navy Departments adopted the name *Texan* for the AT-6 type.

SAWE Meets May 3-5

Revisions of government specifications and procedures, compilation of handbooks for designers and airline operators, and adoption of standardized forms for weight and balance control work are among the items on the agenda of the third annual conference of the Society of Aeronautical Weight Engineers to be held at Texas A. & M. College, College Station, Tex., May 3-5. Howard W. Barlow, national chairman of the society, states that most aircraft and weighing apparatus manufacturers are expected to be represented.

Transcriptions From Front

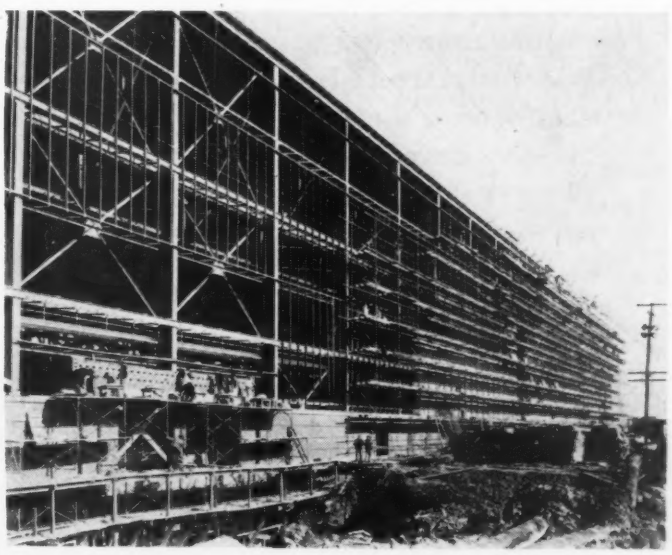
Workers who make the planes now have a new opportunity to hear how Air Forces pilots abroad are using them. Recorded at an Army base in North Africa, four records of pilots' battle experiences in P-38's, B-17's, A-20's, and B-25's have been flown to Washington where copies have been made for distribution through the Industrial Services Division, Bureau of Public Relations of the War Department.

Branch Assembly Plants Being Launched by Vega

Furthering the trend to "bring the work to the labor source," Vega Aircraft will establish branch subassembly plants in smaller communities which still offer manpower, according to Courtlandt S. Gross, Vega president.

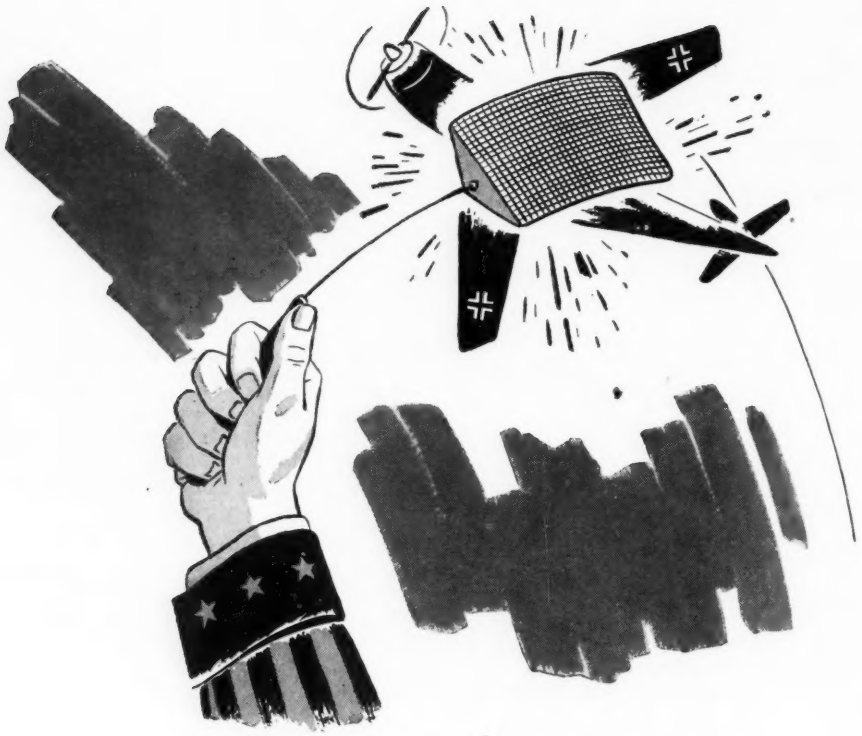
Aimed at avoiding congestion, transportation difficulties, and housing shortages marking the immediate vicinity of the home plant, the first of several such branches is now in process of establishment and others are to follow. No parts will be fabricated in the new outlying plants, rather finished parts will be subassembled.

Extension of this branch plan follows satisfactory experience with the system in another Southern California area.



RUSH GEORGIA BELL PLANT

Supervised by Army engineers, workers are finishing one of massive windowless sides of colossal air-conditioned Georgia bomber plant to be operated by Bell Aircraft. When tooling is completed, workers trained in four schools financed by U. S. Office of Education will begin production on newly-designed, long-range, multi-engined bomber.



CLEAN AIR helps *SWAT 'EM*

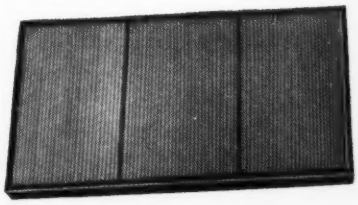
One thing about war. We learn plenty. Take plane engines, for instance. On some fronts, engine wear became a serious problem after only 10 to 30 hours. Today, the same types of engines last 300 hours and more. The difference is that now they breathe clean air.

Air-Maze filters are particularly suited to this job. They have been engineered to efficiently filter high velocity intake air, in restricted, odd-shaped spaces, with weight savings of 35% to 40%, and under the toughest desert combat conditions.

The element is not affected by temperature or moisture. It withstands vibration without packing down. Each cleaning, therefore, restores the original efficiency. *No replacements are needed.*

When you put your problem up to Air-Maze, you're dealing with men who have been designing plane filters since 1926, and who talk your language. It's a good place to start when you want the *right* answer, *quick.*

AIR-MAZE
AIRPLANE ENGINE FILTER



TYPE R-81 FILTER

This filter can be made in any practical size or shape.

The illustration shows precise arrangement of the crimped "approach face" media and the rigid construction.

AIR-MAZE CORPORATION • CLEVELAND, OHIO

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

5,500 Airplanes Turned Out in February; 12,000 Production Rate Seen by December

Washington (AVIATION Bureau)—Aircraft production in January was over 5,000, of which more than 65 percent were combat types. Production in February was about 5,500. These figures were announced by Robert P. Patterson, Under Secretary of War, in accordance with the government's new policy of making public the numerical output of the industry each month. At the same time, Patterson said that in January manufacturers delivered 27,000 50-cal. aircraft machine guns and 7,200 20-mm. aircraft cannon.

A few days before the War Department's announcement, responsible officials stated off the record that airplane output is expected to reach about 12,000 per month by December of this year. This rate would enable the United States to produce about 150,000 airplanes in 1944. Presumably that figure would be close to our maximum, if we went on with our regular gun, tank, and ship programs.

Officials in charge express some doubt whether the industry will be able to turn out the entire schedule reckoned at more than 104,000 planes this year. But it will come very close to the goal—much closer than it came to completing the schedule of 60,000 in 1942. (Total deliveries in 1942: 48,000.)

If the industry fails to deliver the entire program, the main reason will be change orders and increasing complication and size of the planes. Of course, those who accept and reject change orders for Army and Navy will not allow them to cause the reduction of output beyond a certain limit. The balance of quantity must be maintained against quality. In addition to the change orders with which every plant is constantly wrestling (modification centers alleviate but do not eliminate the whole problem) there are new types of planes taking up the time of every manufacturer's engineers, workers, and pilots.

It is never possible, due to censorship, to produce any over-all picture of plant expansion and progress. It can be noted, however, that the Consolidated plant in Louisiana will come-in in a matter of months; Goodyear has started production of Vought's Navy *Corsair;* production of Sikorsky's helicopter starts as soon as possible following the AAF's recent order for 300 of them; Navy has placed orders for North American B-25's, formerly used by Army and the British only; British are taking the Curtiss *Seagull* SO3C-1; and the Higgins plant in Louisiana, which will make Curtiss-Wright C-76 *Caravan* cargo planes, reports progress.

New plant additions will be coming in at intervals the rest of this year. By New Year's Day, 1944, the United States will have an aircraft plant with three times the 50,000-plane capacity the President called for two or three years ago. A good many persons in the industry said at that time that the President was asking for too much. American aircraft is now nearly half of the total war production—greater than Navy vessels or merchants ships or any other one category of weapons.

The industry is still short of special steel forgings and aluminum forgings and shapes. Thus, the shortage of skilled men, and the absentee problem, has not actually reduced the number of planes turned out. The skill and manpower and absentee problems will begin to be really serious when the industry gets more materials than it can turn into airplanes. A strenuous effort is being made to solve these problems before that time comes.

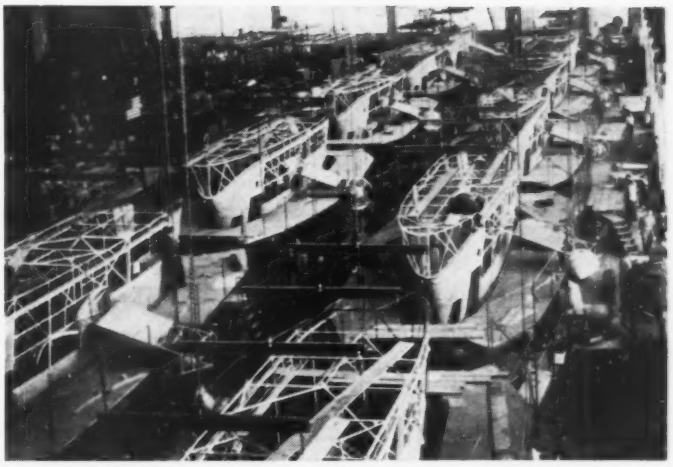
Lockheed, Vega Plants Put "Boypower" to Work

Lockheed and Vega are tapping the boy labor market, and thus far the experiment is described as satisfactory. About 400 boys, 16 and 17 yr. of age, are employed as half-time employees, working a regular day-time shift for four weeks, then resuming their schooling for four weeks.

The experiment was started in February, with cooperation of the Burbank and Pasadena, Calif., school systems. It calls for a twelve-months' school year, and the boys must keep up in their scholastic grades in order to hold their factory jobs. The 400 fill 200 jobs, 200 working while the others are in school.

R. A. Von Hake, Lockheed vice-president in charge of manufacturing, expressed satisfaction with the young workers, stating that their eagerness resulted in their learning their jobs quickly. Guided in their work by school supervisors and given especially through training in safety, the 400 are a test group that may be the forerunner of thousands.

R. A. Von Hake, Lockheed vice-president in charge of manufacturing, watches "boypower" at work. Told they were to work on P-38's, boys cheered as though at a football game. Their enthusiasm has expedited learning their jobs. They alternate four weeks in plant with four weeks in school on twelve-months' school year basis.



BUSINESS BUNDLES FOR BLIMPS

Motor outriggers and other finishing touches are being added to these blimp control cars on Goodyear production line. Navy battle-gray paint will then be applied and they will be fitted to blimp bags.

Goodyear and Brewster Making Vought "Corsairs"

Goodyear Tire and Rubber has started production of the Vought F4U *Corsair* Navy fighter, employing the designation FG-1, and expects to be in full production in "a number of months." Meanwhile, Brewster Aeronautical is also building the F4U under the designation F3A-1.

It is noted that the *Corsair*, heretofore referred to as a Vought-Sikorsky product, now is officially termed merely the Vought following the new demarcation between the two divisions of UAC (p. 387, Feb. AVIATION).

Goodyear's new plant, for *Corsair* fabrication, begun in Feb. 1942, is larger than the huge air dock at Akron. Work on the airplane started long before the building was finished and while machines, dies, presses, and jigs were still being installed. The planes will be taxied from the assembly line directly onto the airport for test and for subsequent ferrying to their destinations following Navy acceptance.

It is unofficially reported that Vought has been extremely particular in checking on sub-producers of the plane's special center sections, which are subjected to rough handling on rolling decks and meantime support no small weight.

Lycoming Breaks Record

Plant expansion and addition of new employees, one-third of them women, enabled the Lycoming Division to double production of aircraft engines and break all previous records in 1942, according to William F. Wise, executive vice-president of the Aviation Corp. "During the past year,"

FLOATS FOR OUR SEAPLANES... *For many years Edo has occupied a position of world leadership in the development and manufacture of float gear for seaplanes. As a consequence of specialization, Edo has long since become the recognized supplier of single and twin floats to virtually every American aircraft manufacturer . . . The war found Edo engineers and production methods ready and the transition to large scale production of float gear for our military aircraft was swift and smooth. With the aid of greatly increased facilities, exacting schedules have been met fully and on time. The Army-Navy "E," flying over the Edo plants, is an assurance that all is well on this sector of the vast production front.*

EDO AIRCRAFT CORPORATION, 402 SECOND STREET, COLLEGE POINT, L. I., N. Y.

EDO FLOAT GEAR

SERVES THE UNITED NATIONS

Mr. Wise announced, "eighty-four percent of the Lycoming Division's production consisted of its largest product, nine-cylinder, 300-hp. radial engines used to power liaison planes built by Vultee and advanced trainers built by Beech, Cessna, Curtiss-Wright, and the Stinson Division of Vultee.

Martin Gun Interrupter On U.S. Combat Planes

Strikingly efficient gunfire interrupters, which keep gunners from shooting off pieces of their own airplanes, have been in use for months by the AAF and presumably by the British. The Army has just released the story, and it may be assumed that the Nazis by now have possession of the device, also that they have one of their own.

The Glenn L. Martin Co. developed the interrupter, now used on several types of combat planes. It is not to be confused with the type of interrupter developed in World War I to enable fixed guns to fire through propeller arcs —for the new unit operates on movable weapons. Those guns which can be brought to bear on the empennage, wings, props, undercarriage, or other parts, have the device incorporated so that there is no risk of human reactions in times of stress. About the size of a quart milk bottle, the unit weighs but a few pounds.

The interrupter does either of two things—shuts off the bullets before the flow of fire swings into any part of the plane or lifts the line of fire over and around the part. It is arranged so that, if the turret has two guns, it does not necessarily shoot off both at the same time, for it works on each independently. If one gun comes into the clear first, it immediately reactivates that weapon.

No details of the device are available. Reporting on it, the Aeronautical Chamber of Commerce says the stream of fire is allowed to come extremely close to parts of the plane, indicating that it is a high precision instrument.

Augments Hydraulic Units

Greer Hydraulics, Inc., New York City, has set up engineering and production management departments for a group of companies now manufacturing hydraulic apparatus under license from large suppliers. Move is to relieve the shortage in standard hydraulic equipment recognized by the Navy.

Assembly Lines

North American's completing more than 10,000 AT-6 training planes (p. 303) includes both complete trainers and their equivalent in parts. The trainers are now in use in Russia, Australia, Canada, South Africa, the British Isles, and sectors which the Air Force occupies. The propotype for the series was the NA-16, first plane designed and built by North American.

Reynolds Metals Co. is stamping and finishing metal airplane parts at its factory rather than shipping the aluminum stock to the aircraft plants for processing. Officials of Douglas at Tulsa, Okla., where Reynolds parts are now in use, have stated that the plan has already effected vast savings in production time, facilities, and costs.

A new $14,000,000 plant incorporated into Consolidated's Fort Worth layout puts under one roof all the operations needed to turn sheet aluminum into complete planes. Three railroad spur lines provide unloading docks for a score of freight cars. The equivalent of nearly 40 miles of railroad line could be laid with the trackage covered by the new plant's overhead monorail crane system.

Goodyear Tire & Rubber Co., Akron, has perfected an artificial rubber known as "Chemigum". It is of sufficient flexibility and resilience to warrant the replacement of other types of compounds in hydraulic accumulators. The accumulator of an airplane is the reservoir in the heart of the plane's hydraulic-control system from which reserve fluid for all purposes is drawn automatically when needed. The synthetic rubber diaphram within the accumulator separates the air, via which pressure is exerted, from the reserve fluid supply. Goodyear is already in production with synthetic rubber packings, sealing rings, and other parts in the hydraulic control systems of airplanes.

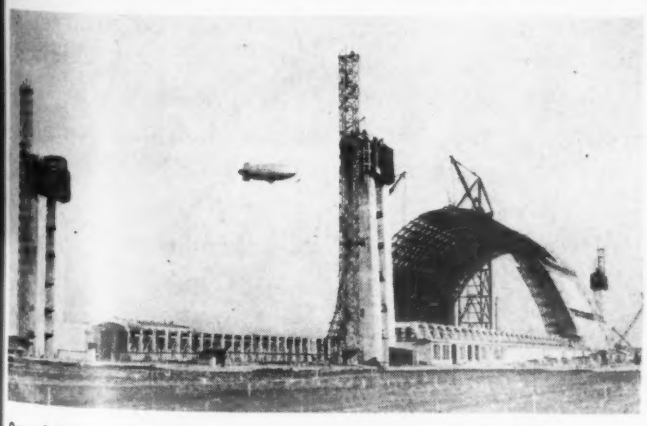
Cessna Aircraft Co. has won Class "A" approval of the AAF for the quality control exercised by its inspection department. This recognition signifies that the company's inspectors are to be entrusted with full responsibility of assuring that planes meet all requirements of the A.A.F.

Wood Replaces Steel In New Blimp Hangars

Only the doors will require steel in the new fireproof, wooden blimp hangars designed by the Navy's Bureau of Docks and Yards and being built along the Atlantic Coast. About 1,000-ft. long and 17-stories high, the hangars call for about 3,000,000 ft. of timber each, 750,000 ft. of it in the arches, nearly 250-ft. high, said to be the largest ever constructed of wood.

A mixture of ammonium and boron salts has been used for fireproofing the wooden sections, which rest on 24-ft. concrete bases housing shops and offices. The webbed arches, varying in width from 19 ft. at the base to 13 at the peak, are fastened with 4-in. split-ring or shear connectors and ¾ in. bolts.

The doors are to be set in concrete columns (see photo) at each end of the main structure. But to alleviate the problem of constructing the arched roof strong enough to resist wind pressures against the doors, the door-columns will not be attached directly to the body of the structure.



One of huge new fireproof wooden blimp hangars now being constructed by Navy along Atlantic Coast. Lofty arches are nearly 250-ft. high. Doors—only part requiring steel—will be swung from concrete pillars at either end of structure.

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CAB Asks Eleven Airlines to Show Cause Why Passenger Rates Should Not be Cut

Washington (Aviation Bureau)—After 16 yr. of independent passenger rate making, the airlines—at this writing, eleven of the major lines—are now called upon by the Civil Aeronautics Board to show cause why they should not cut their fares by 10 percent.

The board's action on passenger rates was not unexpected, although the airlines, warned several times about these rates in connection with the fixing of .3 mill airmail rates, are reported to have taken no action in the matter of passenger fares.

In its order, the board states that airline traffic of all classes, between July and Nov., 1942, was not appreciably less than the amount carried in the same period of 1941, although many of the carriers' aircraft had been turned over to the Army, the "take" running to about half of the equipment. CAB further states that the average payload on each plane in latter 1942 exceeded the loads of the earlier period and that the passenger and express revenues for each mile flown were correspondingly increased.

Carriers under contract with the War Department, CAB says, are receiving substantial amounts of indirect expenses which would otherwise be chargeable to their scheduled operations. Several of the lines operate domestic and overseas Army services, using many Army planes, along with some of their own planes. In addition to the allocations of expenses to the lines, they receive regular contract rates for their Army mileage.

Net incomes reported by the airlines during the five months ending Nov. 30, 1942, were excessive, the board says, and may continue to be, and in view of such income, the rates "collected by each of the respondents for the transportation of passengers are and will be unjust and unreasonable."

Last July 1, at the request of the airlines, the board allowed the carriers to suspend their scrip discount of 15 percent and their round trip discount of 10 percent. The airlines asked this permission because they thought, at the time, that removal of about half of their airplanes, plus cutting of their schedules and routes, would seriously curtail their earnings.

The board says that economic stabilization and price control require that, so far as maintenance of sound financial condition of the lines will permit, revenue per passenger be restored to the approximate level existing before the elimination of discounts.

Weather-Cadet Training

Washington (Aviation Bureau)—The War Department has started a new cadet training program which by 1945 should graduate more than 10,000 meteorologists for the Air Forces' world-wide weather forecasting system. Immediate needs for trained personnel will be supplied by continuing the present nine months' intensive professional courses.

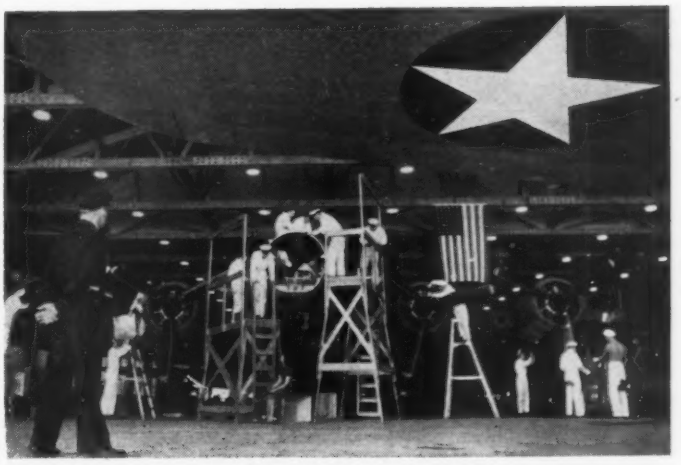
Basic and intermediate instruction, as well as the Air Forces' advanced courses, will be conducted at 27 universities and colleges and at the Technical Training Command's school in Grand Rapids, Mich.

PAA Starts Night Flights Serving Latin America

In order to cut a day from the flying time between the important war-activities areas on the West Coast of the United States and the strategic Canal Zone, as well as the important defense centers in Latin America, Pan American Airways has inaugurated the first night flying in Latin America over the Los Angeles-to-Mexico City route.

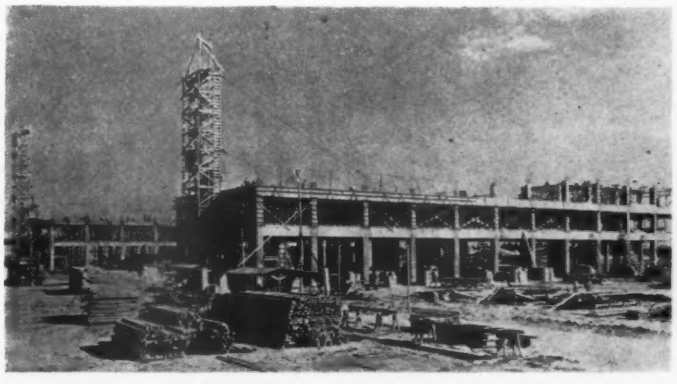
The schedule not only gives the West Coast an immediate connection with international southbound *Clippers* at Mexico City but also makes direct connections to Tampico and the Gulf Coast cities of Mexico. The new route is operated by PAA's subsidiary in Mexico, Cia. Mexicana de Aviacion.

Establishment of the new lighted airway involving a cost totaling nearly $500,000, represents a great military adjunct for the fighting air forces of the United States and Mexico. Powerful radio direction finding stations and lighted airports are situated along the length of the route.



UAL MODIFICATION CENTER

View inside United Air Lines' Wyoming modification center. This is separate unit from regular maintenance base, one of many throughout country run under supervision of AAF Materiel Command by cooperation of both airlines and manufacturers. Here, bombers are received from production line and fitted for special war tasks, saving time in production and keeping our planes up to minute.



PAA Florida development. One of two new buildings going up at Pan American's international terminal, Miami, this four story hangar and office building will cover almost four acres. Completed unit will permit simultaneous servicing of 12 to 18 planes. Shop-office buildings will be occupied by fabric and equipment, metal shop, stockroom, locker space, maintenance offices, flight personnel and maintenance schools, engineering, instrument overhaul, and assembly rooms. An enlargement is also being added to terminal which will handle loading and unloading of two or more clippers at same time.

U.S.-Canada Air Service Agreement Reaffirmed

Washington (Aviation Bureau)—Continuation of the present air transport agreement and air services now operating between the United States and Canada has been agreed upon by Under-Secretary of State Sumner Welles and Prime Minister McKenzie-King. Our relations with the Dominion are now under consideration by the President's Interdepartmental Aviation Committee, which is attempting to formulate our policy on over-land and over-sea air rights. Feeling that their bargaining position is now stronger than it may be at the end of hostilities, the British are also pressing for an understanding on all international air transport.

Consequently informed people here are convinced that the questions of air rights and airports of entry will have to be settled before peace conferences begin.

IASC Award to PAA

Two divisions and two affiliated companies of Pan-American Airways have been awarded certificates by the Inter-American Safety Council for flying nearly 190,000,000 passenger miles and over 15,000,000 plane miles without a passenger fatality during 1942. Lines honored were the Eastern and Western divisions of PAA, the Compania Mexicana de Aviacion, S. A., and the Compania Nacional Cubana de Aviacion, S. A.

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House of Lords Debates Development Of British Postwar Civil Aviation

Future of British civil aviation has been very much in the public eye lately, but a recent discussion in the House of Lords shows that little can be done at present to improve the prospects. Critics of the British government are by no means unanimous in their demands. Lord Londonderry, himself a former Secretary for Air, was in favor of transferring civil aviation from the Air Ministry to a separate Ministry of Air Transport or, possibly, a reconstructed Ministry of Transport, thus subjecting aviation to the same control as land and sea traffic. Lord Mottistone also favored a separate ministry to direct Air Transport and Research. Viscount Bennett, the former Canadian Prime Minister, finding the fault in another place, demanded the reorganization without delay of the British Overseas Airways Corp. He declared its directors should have no interest in any other enterprise, there should be a managing director, the best executive organization money can buy, and regional managers, accountable to their managing director, for the North and South Atlantic routes. The Duke of Sunderland proposed the establishment of an Air Transport Command in the RAF, and Lord Brabazon made a similar suggestion by recommending formation of an Air Transport Corps in the RAF. All speakers thus seemed to find fault with the present organization of British civil aviation and the government was charged with lack of policy.

The government's reply was given by Lord Sherwood, Joint Under Secretary of Air, who emphasized that the government was giving earnest study to the problems of civil aviation and to the types of aircraft which would be required after the war. Close attention was being given to the modification of bomber types for transport, he pointed out. Until new types of transport aircraft could be produced, these converted bombers would meet the need. But if first-rate designers were now diverted from war work, it would be at the expense of the war effort. The government spokesman agreed with those of his preceding speakers who had urged cooperation with the Dominions and the United States. A policy of freedom of the air without any international regulation would mean fiercer competition than any yet seen, together with intensification of heavy national subsidies, he said.

It was in the interest of the world, he continued, that when peace returned, collaboration on the air routes of the world should be equally as close as collaboration between the air forces of the United Nations was now. No decision could be taken by any one nation. The various issues were being closely considered by the government and would be discussed as soon as practicable with the Dominions and other members of the United Nations, he concluded.

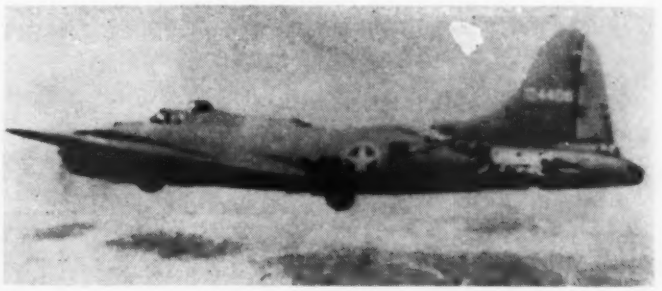
A Technical Committee to investigate civil aviation problems had been appointed under Lord Brabazon as chairman, and its report was handed to the government in February. Its recommendations have not been made public, but that there is no lack of interest in outside quarters is shown by many symptoms, not the least being the speeches of shipping magnates who have been very frank on the need to bear civil aviation in mind when making plans for the future.

The Association of British Chambers of Commerce, the Federation of British Industries, and the London Chamber of Commerce have set up a joint committee on civil aviation.

Reference of the subject to a technical committee by the government does not mean that it is to be shelved, but as far as international discussions are concerned, the British Foreign Secretary has stated that none had yet been entered into, "although postwar civil aviation is one of the many subjects which will call for consideration with other governments with a view to reaching an agreement acceptable to all."

New Dual Bomb-Timer Wreaks Havoc on Enemy

Royal Air Force has revealed a new type of delayed action bomb that is working serious damage upon the enemy. The bomb has two detonating mechanisms. One touches off the explosion hours or days after the bomb has been dropped in the target area; the other sets it off when it is touched or moved in any attempt to devitalize it or remove it from the locality.



International News Photo

. . . BUT "FORTRESS" STAYED UP

German fighter, with dead Nazi at controls, crashed into tail of this Boeing "Flying Fortress." Despite heavy damage to tail, Pilot Kenneth Bragg, of Savannah, Ga., brought the craft back to her North African base.

In the case of bombs that explode on contact, the enemy immediately moves back into his factory, water front, or whatnot, and begins clearing and repairing to resume operations. And as for simple delayed-action bombs, all belligerents now know how to unhook their timing gears and haul them away. But the new dual mechanism forces the enemy to evacuate the target area and stay away—for days or weeks. The nervous strain is intense.

Bad feature about such inventions is that the enemy soon adopts them, too. But in the European theater, the Nazi air force appears no longer able to assault England in formidable numbers.

Will They Come Up With Lopsided Luftwaffe?

In an effort to explain the notable absence of the German air force on all fronts of the war, reports coming out of Germany tell of a complete reorganization of the Nazi airplane industry to build planes based on the Blohm and Voss BV-141 asymmetrical design.

The Germans seem to feel that this design, when their plants reach full production again, will be sufficient to offset the growing Anglo-American air offensive.

The original plane, described in an earlier issue of AVIATION, featured a long engine nacelle with normal rudder and a half stabilizer and rudder, with the pilot's and observer's nacelle perched out on the wing. This plane never saw actual service in combat zones, however, and the sudden silence which enveloped it after preliminary tests may point to major faults in the design.

Rational review of the announcement also makes it extremely unlikely that even the Germans would suddenly cancel their whole production program, which has brought out some planes which can be classed among the better types now in combat service and then swing over to a new and untested type at a time critical to their home defense.

It is more likely that Nazi plants are seriously disorganized by air attacks, and that the announcement is for home consumption to stop German questions about the Luftwaffe.

British Overseas Airways Reports 1942 Records

British Overseas Airways covered a total of about 10,000,000 mi. in 1942, requiring an aggregate of about 67,250 hr. flying time to get over this distance. The average mileage per flying hour thus works out close to 150 mi.

Approximately 43,000 passengers were carried, in addition to 850 tons of mail and 2,250 tons of freight. The passenger mileage was approximately 91,000,000. Average distance over which passengers were carried was thus rather more than 2,000 mi. proof of the importance of transatlantic and other intercontinental flights. About 21,600,000 ton-miles are recorded for mail and freight capacity, but obviously partial use was only made of this capacity.

BOA's flying boats operate on many sea routes. Last year they were seen between Baltimore and Britain, Baltimore and Lagos (West Africa), Britain and Lagos, Britain and Lisbon, and South Africa and India—the western half of the Horseshoe Route which before the fall of the East Indies extended to Australia.

Landplanes also operated between Britain and West Africa and did service between the Middle East and Iraq and

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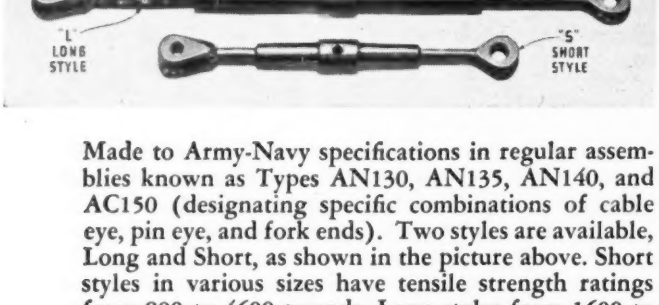
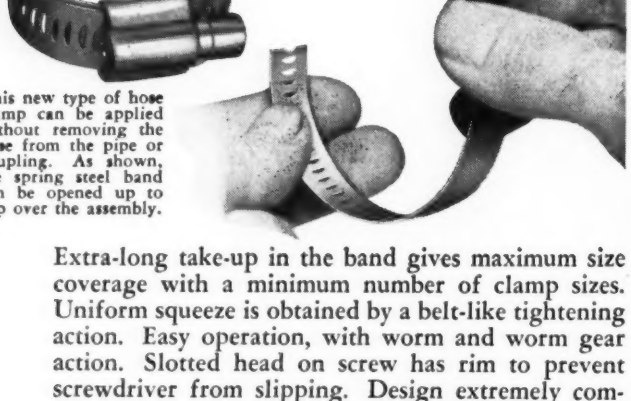


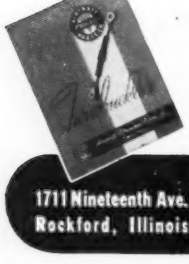
Made to Army-Navy specifications in regular assemblies known as Types AN130, AN135, AN140, and AC150 (designating specific combinations of cable eye, pin eye, and fork ends). Two styles are available, Long and Short, as shown in the picture above. Short styles in various sizes have tensile strength ratings from 800 to 4600 pounds, Long styles from 1600 to 17,500 pounds. Components may be ordered separately for ultimate combination on the manufacturer's final assembly line. Rigid quality control maintained throughout all manufacturing operations. Made on high production precision machinery, formerly used on commercial products.

"AERO-SEAL" HOSE CLAMPS



This new type of hose clamp can be applied without removing the hose from the pipe or coupling. As shown, the spring steel band can be opened up to slip over the assembly.

Extra-long take-up in the band gives maximum size coverage with a minimum number of clamp sizes. Uniform squeeze is obtained by a belt-like tightening action. Easy operation, with worm and worm gear action. Slotted head on screw has rim to prevent screwdriver from slipping. Design extremely compact. For hoses 1" diameter and larger. Quality construction throughout.



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Persia, and between the Middle East and various parts of Africa. The organization also ran services across Africa to the Middle East—which is thus a very important aviation center with connections to the West, South, and East. The "Desert Service" links Cairo with the Western Desert. In addition there are other lines about which no information is given for security reasons.

Nazis Threaten Raids On American Cities

Infuriated by the devastating raids on Berlin by the RAF and other blows by the USAAF on such important centers as Wilhelmshaven, the German radio threatens that American cities may feel the weight of German bombs this summer.

While this admittedly is more propaganda than anything else, it is well known that the Germans have several types of bombers now in production which could fly over to this country with medium loads of bombs, even if they might not get back.

As the Nazi position grows more desperate on all fronts, most experts believe that some suicide raids will be attempted on the United States East Coast, perhaps using the new Heinkel He-177 and a long-distance version of the Junkers Ju-90, which has been revamped with a new tail and new wings since its catastrophic debut during the invasion of Holland.

Large airports have been reported constructed both in Norway and France, with two-mile runways pointing out to sea in the general great circle route to the American continent. These airports are undoubtedly for the primary purpose of convoy attacks, the length of the runways being necessary for some German planes used for these raids, which have wing loadings running over 60 lb./ft. But the possibility of their use to get planes into the air headed for American industrial centers should not be discounted.

There is a further possibility that either catapult ship or submarine based aircraft may be used for token hit-and-run attacks on American cities, and the experience many German crews had in flying their four-engined planes in and out of Port Washington Bay should not be forgotten.

Re Nazi "Rocket" Takeoffs

Anent use by the Nazis of modified "rocket" engines to assist takeoffs of heavily loaded bombers, it is pointed out that some of the latest German planes have wing loadings at full load approaching 60 lb./sq.ft., or some 50 percent over what we consider a safe limit in this country.

This fact highlights the need for extra takeoff power on those runways which are not two and three miles long, like those used for the *Kuriers* in France and Norway.

Besides this use of jet propulsion, study of planes downed in England indicates that some sort of mechanical towline is also employed. Moreover, it is also possible that the Nazis are using catapults, with which they are highly experienced, to get 30,000-lb.-plus planes into the air from hidden points.

Uruguay Training Up

The new Military Aeronautics School in Uruguay was recently opened, three months ahead of schedule, to cope with the problem of providing training of new pilots for the lend-lease planes which are arriving from the United States in ever increasing quantities. The director of the new school announces a further program of course compression to speed advanced instruction, so that Uruguay may take her place in hemispheric defense at an early moment.

New airbases are being prepared all over the country and enlarged to handle the planes from all South American countries, which are expected to join hands in continental air operations.

Canadian News

By James Montagnes

The Avro Anson Mark V latest model of this twin-engined bomber-trainer to come from Canadian factories, was given its tests before Royal Canadian Air Force officers late in January. The Mark V is equipped with Pratt & Whitney radial motors instead of the Jacobs engines used on previous Canadian - built models. Redesigned interior of the *Anson* gives more room for student navigators and observers, and the molded plywood fuselage makes it far quieter and warmer than its predecessors. Its normal crew is a staff pilot, a navigation instructor, two navigator students, and a radio operator student. There is a bombardier's compartment in the nose for bomber students.

The *Anson* is made by the government - owned Federal Aircraft, Ltd. An order for more than 2,000 of the Mark V has been given the company, and a Mark VI has already been placed on the boards, differing in that it has a power-operated turret and will be used for gunnery training. Work on the Mark VI starts as soon as the Mark V order has been completed.

Trans-Canada Air Lines, Ltd., government-owned transcontinental transport and passenger operator, has increased its paid-up capital from 75 to 92 percent. Canadian National Railways, publicly owned, which operates TCA, put up an additional $850,000, increasing its investment in the airline to $4,600,000. Additional capital financed purchase of new equipment, including six Lockheed *Lodestars*, which have already been delivered.

A new Canadian company has been formed to manufacture plastic bonded, molded plywood fuselages for aircraft. The new company has started operations in Ontario with 200 men, will be known as Cockshutt Moulded Aircraft, Ltd., and is capitalized at $1,000,000.

The Canadian government has started a nation-wide plan to encourage aircraft workers to submit suggestions for the improvement of efficiency and production in aircraft plants, it is announced by Ralph P. Bell, director-general of aircraft production. The government will annually award certificates of merit to 25 workers in Canadian aircraft plants, each certificate carrying a prize of $25. In addition, the individual plants will give prizes determined by a percentage of the saving resulting from the suggestion. These will vary from $2 to $500.

To combat the high fees of commercial schools which collect from students after they have placed them in posts in aircraft factories, the Ontario and Quebec governments, with federal government assistance, are opening schools and charging a nominal fee, it was announced recently by Hector Perrier, provincial secretary in the Quebec provincial government.

A propeller plant which started in Manitoba in 1939 in a one-story plant has recently turned its 10,000th propeller over to the Royal Canadian Air Force. S & S Aircraft, Ltd., began by turning out three wooden propellers a day, now is turning out up to 50 propellers of seven major types a day, as well as numerous test designs. Several of the machines used at the plant were designed by company men.

Failchild Aircraft Ltd., Quebec, has started music-while-you-work service for the night shift.

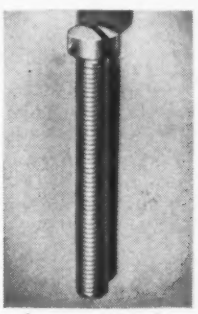
On Schedule . . . by "Vista"

In Sweden a new company has been set up for postwar transatlantic operations with a reported capital of $2,500,000. As has been previously reported in this column, the Swedish ABA has been maintaining an admirable number of airlines during this war, and while the new company is not named or further described, it is safe to assume that ABA will have a large part in it. Representatives of the Swedish airline and government were in this country in 1939 trying to get a permit to enter the United States from the north, but they apparently got little further than others previously. Connected with this attempt at the time were most of the large shipping lines and even some of the Swedish railway interests, which were putting up the capital together for the new venture.

The whole project took on a form which was copied in some other countries, notably Norway and Holland, where the nuclei of similar ocean-flying organizations were set up. The Netherlands plans in particular took on a final form during the hectic months which passed before the Nazis started on their rampage, and all the necessary permits were available for a regular service across the South Atlantic via Portugal and the Cape Verde Islands. Planes had already been ordered in this country, notably the DC-4 and Lockheed *Excalibur* in special long-range versions, and a DC-3 had been equipped in Holland to carry a crew of six, four passengers, mail and freight on a regular bi-weekly service. Then the war made all this impossible. This proposed line had no parallel until the United States' Air Transport Command started its operations. All other plans were directed via the Northern Atlantic, with the route running from Iceland by way of Greenland to Botwood and Canada.

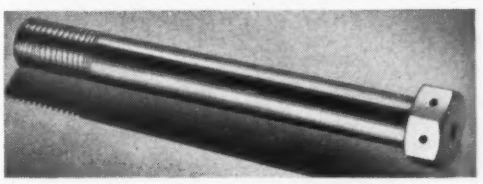
Freedom of the Air is still being hotly contested, with almost everyone joining the fray. At any rate, general opinion seems to indicate that some form of postwar airline planning is strictly necessary—and that it should be done before the shooting ends in order to allow for a continuance of air services to all parts of the world.

DRILLED FILLISTER HEAD MACHINE SCREWS



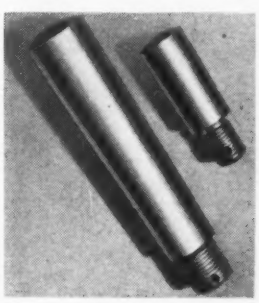
Used in many assembly operations and hence available in several types and a wide range of sizes. Low-carbon screws, for ordinary uses where high strength and close tolerances are not required, made to Air Force drawings AC500A and AC501A. Heat-treated nickel steel screws, for more particular applications where screws are appreciably stressed, conform to Army-Navy drawings AN502 and AC503. For close positions, where double cross-drilling is desirable, nickel steel screws conform to Navy drawing NAF-1164. Plating is bright and uniform. Nickel steel items identified by "X" on head.

STEEL DRILLED HEAD AIRCRAFT BOLTS



Generally known as "Engine Bolts" and widely used in aircraft construction where bolts with heads drilled to accommodate lock wire are required. Holes drilled through all faces to meet center hole in top of hexagon head. Made of heat-treated nickel steel to conform with Army-Navy specifications, in types AN73 through AN81 and sizes up to 6" length. Also in coarse thread (NC3) or fine thread (NF3) styles. Carefully inspected and tested for quality, accuracy, and uniformity. Cadmium plating conforms to AN-QQ-P-421. Identified by "X" on head.

THREADED TAPER PINS



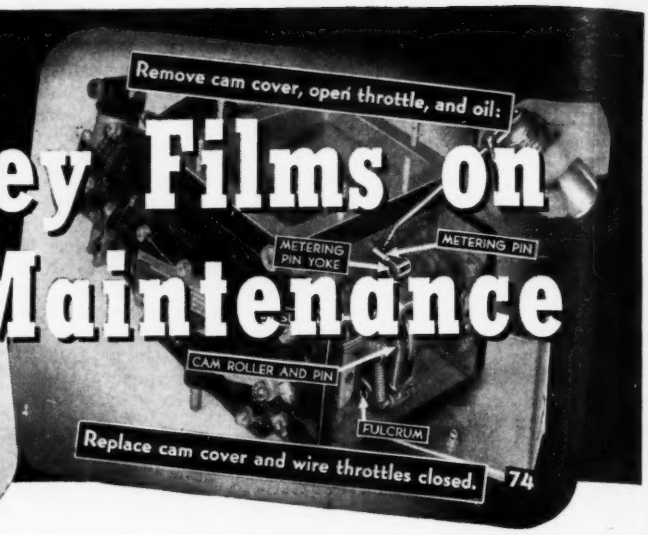
Specially-designed pins, generally used in aircraft construction in place of commercial taper pins. Made to conform with Air Force drawing AC386 in sizes from 1 through 5. Can be furnished with threaded end either drilled or not drilled for cotter pin. Material is nickel steel of Army-Navy AN-QQ-S-629 specification, cadmium plated in accordance with AN-QQ-P-421. Centerless ground after hardening to insure accuracy and uniformity. Companion AN975 washers also available.

CATALOG AND ENGINEERING DATA

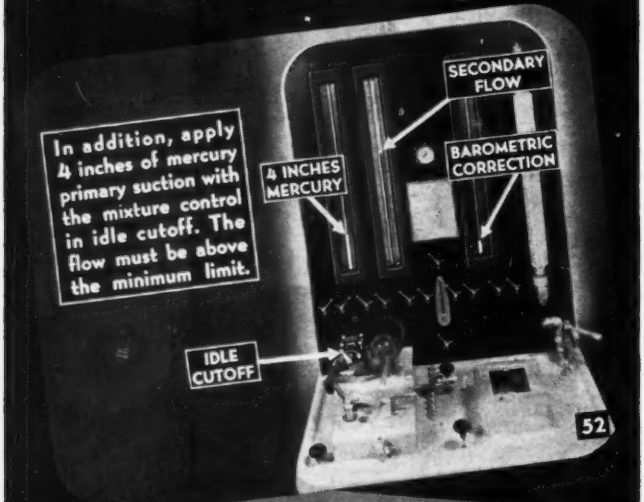
Send for your copy of new Catalog No. 101, showing complete prices and engineering data on Hexagon and Drilled Head Bolts, Clevis Bolts and Pins, Fillister and Washer Head Screws, and Threaded Taper Pins.

AERO SCREW COMPANY
19th Ave. at 12th St., Rockford, Illinois

11 New Holley Films on Carburetor Maintenance



The test stand consists of:
1. A fuel system.
2. An air suction system.
3. An air pressure system.
4. An electrical system.
5. Various controls, gages, and accessories.


In addition, apply 4 inches of mercury primary suction with the mixture control in idle cutoff. The flow must be above the minimum limit.
SECONDARY FLOW
BAROMETRIC CORRECTION
4 INCHES MERCURY
IDLE CUTOFF
52

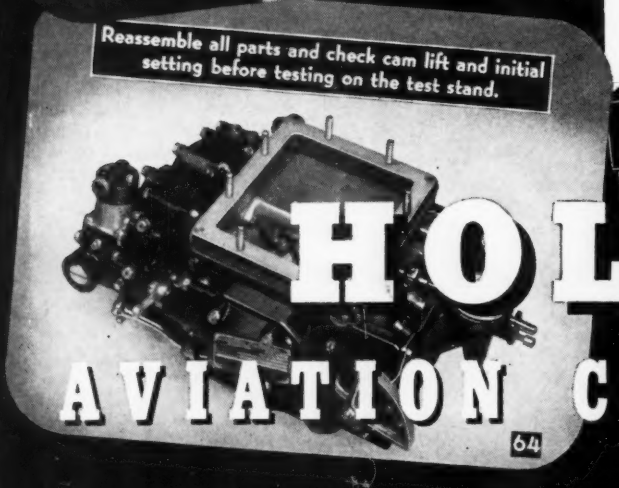
A new series of 11 training films on Holley Carburetor Maintenance is now available to authorized technical groups and schools at a cost of $35.00.

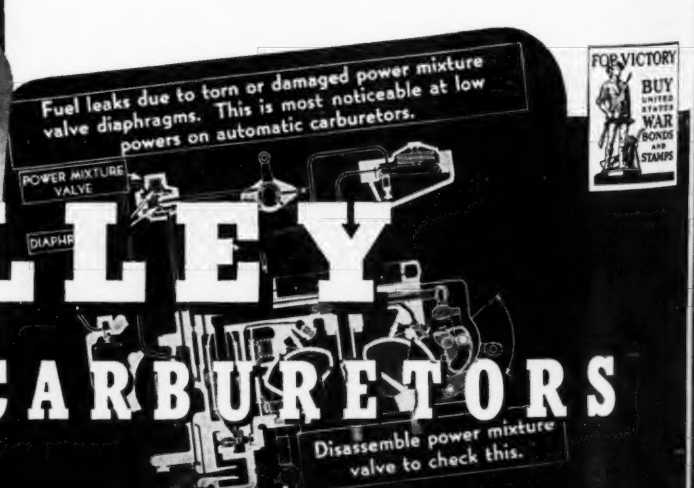
More than five months were spent in the preparation of these films, and only a portion of the cost is represented in their price. The first film, on carburetion theory, is in full kodachrome.

Subjects include theory of carburetor operation, installation, overhaul, use of Holley Test Stand, inspection, testing, trouble shooting, storage and reconditioning.

Films will be shipped promptly upon receipt of order, or further information may be had by writing.

HOLLEY CARBURETOR COMPANY
DETROIT, MICH.




Fuel leaks due to torn or damaged power mixture valve diaphragms. This is most noticeable at low powers on automatic carburetors.
POWER MIXTURE VALVE
DIAPHR
Disassemble power mixture valve to check this.

HOLLEY
AVIATION CARBURETORS

Aviation Finance

Bendix Aviation Corp. has arranged a three-year $150,000,000 regulation "V" loan with 60 banks, and the initial borrowing is expected to be at least $40,000,000. The company's war production is now at the rate of $700,000,000 annually with additional facilities soon to be available for a further substantial increase in output calls for larger working capital. Bendix had bank loans totaling $10,000,000 at the close of its 1942 fiscal year.

Continental Motors Corp. also is negotiating a $35,000,000 stand-by credit of the same type with a group of banks because of the greatly enlarged demands now being made upon its productive capacity. Recent financial reports issued by Consolidated Aircraft Corp. and Vultee Aircraft, Inc., reveal bank loans of $25,000,000 and $7,908,000, respectively.

North American Aviation reports sales of $242,595,085 for the fiscal year ended Sept. 30, 1942, from which net income after all charges totaled $10,436,413 or $3.04 per capital share. This compared with $6,075,954 or $1.77 a share earned in the fiscal period ended Sept. 30, 1941, which, however, covered nine months only. The amount of $1,681,594 was added to the contingency reserve, while $3,506,594 was charged to sales costs to create reserves for inventory losses and to cover the loss sustained on two contracts. Results for the year are subject to contract renegotiation and consequently may not be final figures.

A hint of dividend policy of the new Consolidated Vultee Aircraft Corp. is given stockholders in a letter from T. M. Girdler, Consolidated chairman, and Harry Woodhead, Vultee president, which states that regular quarterly dividends will be initiated on the preferred stock on the first quarterly dividend date following completion of the merger, while dividends "will be paid upon the common stock commensurate with earnings and sound fiscal policies."

Consolidated Aircraft reports net sales of $304,013,649 for the year ended Nov. 30, 1942. This was after voluntary returns and price reductions during the year of around $127,000,000, which alone exceeded total sales of $95,529,000 in the like 1941 period. Net income totaled $10,323,779 or $8.04 a share, compared with $8,024,882 or $6.22 a share for the eleven months ended Nov. 30, 1941.

By RAYMOND HOADLEY

THE FEDERAL RESERVE BANK of San Francisco recently made a comprehensive study of the wartime financial policies of the Pacific Coast aircraft business, pointing out that the industry is buttressing its future position by setting up large reserves for postwar readjustment purposes. But the survey also reaches the significant conclusion that it is unlikely that any thing the companies themselves can do will protect them completely should the postwar demand for airplanes fall to very low levels.

A study of the 1942 balance sheets of almost any aircraft company might well leave the stockholder bewildered. The industry, it is true, suddenly has become the biggest in the United States—much larger in value of products produced than the giant steel industry and several times larger than the peacetime automobile industry ever was. It is dealing today with *hundreds* of millions of dollars instead of the mere millions of yesterday. But the increase in size hasn't resounded to the benefit of the stockholder as much as one might suppose.

Balance sheets show that cash items have increased many fold in the course of only twelve months. But in many cases unpaid tax liabilities exceed the cash position. Inventory accounts, on the asset side, are swollen to almost fantastic heights and will surely trend higher in view of the program to double plane production this year. But what will happen to the market value of these inventories after the war?

The growth in current liabilities in the course of this industry's great war task has nearly kept pace with the spectacular rise in current assets. The government, of course, is financing a large share of the industry's working capital needs right now, but it might be noted that bank loans are becoming the rule throughout the industry rather than the exception.

There was some hope last fall that Congress was giving the aircraft companies a little break when provisions were made in the 1942 revenue act for postwar excess profits refunds. However, a glance at the financial statement of a plane maker that paid more than $21,500,000 in federal taxes last year shows a postwar tax credit of only around $250,000. More than ever, the aircraft industry now appears a prime example of profitless wartime prosperity.

Bellanca Aircraft Corp., one of the few aircraft concerns to report a loss in 1941, showed net profits of $690,835 in 1942, or $3.01 a share, compared with a deficit of $151,954 the previous year. Like nearly all of the aircraft manufacturers, the Bellanca report takes pains to point out that adjustments of the 1942 figures may be necessary as war material contracts are subject to re-negotiation involving possible retroactive reduction in sales prices.

Combined earnings statements of Consolidated and Vultee present a picture of what the merged company will look like. On the basis of the 1942 profits of the individual companies, the combined net income for that period of the combined companies amounted to around $10.50 a common share of Consolidated Vultee Aircraft Corp. after deducting about $4 a share for postwar reserves and rebate. However, it is estimated that $9,000,000 or nearly $6.50 a share is left open for re-negotiation of contracts. Deducting this possible additional charge against earnings would leave around $4 a share net profits. This assumes, of course, that the government secures the maximum amount still open to negotiation as this was written.

Taylorcraft Aviation Corp. has authorized payment of three back dividends of 25c each on the preferred stock, clearing up all accumulations on the issue. **Republic Aviation Corp.** also recently paid an initial dividend of 25c a share on the common stock. **Continental Motors** declared a first quarter dividend payment of 15c a share on the common stock.

Vultee Aircraft reports net sales of $109,772,850 for the year ended Nov. 30, 1942, compared with $34,057,207 in the preceding twelve months. Net income amounted to $4,291,140 or $3.33 a common share, compared with $3,100,735 or $2.95 a share of common stock in the similar period for 1941

Pan American Airways announced a 10 percent reduction in passenger fares between Los Angeles and South American points early in March. Two days later the Civil Aeronautics Board requested eleven domestic airlines to show cause why their passenger rates should not be cut by a similar amount (see Transport news section).

Breeze Corp. reported unfilled orders amounting to $43,969,000 at the 1942 year-end compared with $22,064,000 the previous year. Sales last year totaled $38,699,000 against $16,156,000, while net earnings were $1,279,583 or $4.91 a share.

Airline financial reports, as expected, show notable gains over 1941 in all the reports for 1942 that have been issued so far. Transcontinental & Western Air, Inc., reported net profit last year of $2,176,035 compared with a net loss of $487,613 in 1941. Almost half the $16,044,632 operating revenues in 1942 was attributed to a gain in express revenues. Earned surplus was increased by $1,044,380 realized from the sale of equipment to the government.

Western Air Lines, Inc. reported 1942 net profits of $693,703 or $1.69 a share, compared with $5,981 or 1c a capital share in 1941.

Jack & Heintz, Inc., maker of airplane parts in Cleveland, is pouring 80 percent of its net profits into a reserve fund to provide work for its 6,200 employees in the postwar readjustment period. Already $1,500,000 has been set aside for this purpose, according to a recent statement by company officials.

American Central Mfg. Co., did nearly three times the wing and aircraft parts volume in 1942 that it did in 1941 while earnings totaled $469,177 or $1.54 a share against $115,338 or 38c a share the previous year.

Aviation Corp. reported net earnings of $4,723,894 or 82c. a share for the year ended Nov. 30, 1942 compared with net of $2,454,142 in the corresponding 1941 year. The company's equity in undistributed earnings of associated companies, including New York Shipbuilding, Vultee Aircraft, and American Central Mfg. Co., amounted to 55c a share compared with 45c the previous year.

United Aircraft Corp. reports 1942 sales of $519,000,000 against $298,000,000 in 1941. Despite this large gain in shipments, the company had only a slight gain in total assets last year. Net earnings amounted to $17,096,841 or

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$5.95 a common share after provision for preferred dividends, compared with $16,721,380 or $6.29 a share in 1941. Reserves set up for conversion from war to postwar conditions now total $23,897,270, of which all but $10,000,000 was established in 1942. Regarding dividend policy, the report commented that "common dividends are at a rate as high as is considered consistent with the maintenance of financial stability." Unlike many aircraft firms, United was able to complete its renegotiation of contracts with the government before the annual report was issued. This means that earnings reported are not subject to adjustment, as was the case of most other reports issued up to the middle of March. Frederick B. Rentschler, company chairman, told stockholders that United's officers and directors felt that "the best interests of industry and the public are served by industry's acceptance of the principle of re-negotiation of war contracts." The report showed that 59 percent of shipments in 1941 was for the account of the federal government and net profit on those sales was 5 percent, while in 1942 government shipments jumped to over 86 percent of total sales but profit margins declined to slightly less than 2 percent.

Ryan Aeronautical Co. reports net profits of $56,444 or $1.27 a share for the year ended Oct. 31, 1942, compared with $669,603 or $1.52 a share in the prior ten months fiscal period. T. Claude Ryan, president, revealed that the company had been selected to build a new combat plane in a program which "offers greater future possibilities than the former program." Sales totaled $19,620,000 against $8,390,201 in the ten months ended Oct. 31, 1941.

ON THE RAW MATERIALS FRONT

NOW THAT THERE IS an active and somewhat stabilized front in North Africa, the Allies have a new source of secondary metal—the so-called battle scrap. In the case of aluminum, as well as steel and copper, this may prove to be an important source of scarce metal. In fact, the British and Russians both have worked out such efficient methods of handling "crash" aircraft that defense officials point out they have been able to provide a considerable portion of their aluminum supply from this particular source.

Some battle scrap has been brought to Hawaii, but it is understood that to date very little has come to the American mainland. So far, no procedure has been worked out to handle such scrap here. Assuming that there may be ballast space for such material, no one knows exactly where the ships will make port or that there will be scrap dealers available at these points of entry to care for the incoming metal.

Military officials say they have troops who have definite knowledge of metals and who are thus equipped to do general sorting. But they add that it would be a great help if civilian sorters could be sent abroad to aid. Upshot of the matter probably is that aluminum scrap from Africa is likely to be sent to Great Britain for some time to come, certainly until a plan is worked out to care for it in this country. Such a reclamation plan, it is reported, is being worked out for copper.

Meanwhile, production of aircraft is increasing faster than facilities can be provided. It appears that aluminum extrusion output, for example, will be rather critically tight for the next four or five months.

It seemed a few weeks ago that the United States should be completely independent of imports of high grade bauxite for aluminum metal by May. Due to the shipping difficulties in bringing the superior ore from Dutch Guiana, the government had planned to convert older aluminum plants to low grade domestic ore and have the job far enough along by next month to assure a continuous supply of aluminum metal from domestic ores.

But this huge conversion program has encountered much the same difficulties as have the synthetic rubber, high octane gasoline, and escort vessel programs—all of which overlap in the matter of plant equipment. Thus schedules have had to be rearranged, and in the shuffle aluminum plant conversion, like some of the others, has been set back several months.

That also means that the United States probably will not be able to meet all of Canada's aluminum requirements from domestic ores by September, as originally planned. In fact, it is understood that completion of some of the new American aluminum plants has been retarded somewhat.

Net result is that the supply of aluminum metal is more of a problem in the forepart of 1943 than aluminum fabricating plants—the reverse of the situation in 1940-42.

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Custom Built Wheels, just the right wheels for your particular job, no matter how precise or difficult it is.

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Years of research and Specialized* experience are behind each Chicago Grinding Wheel.

You can depend on prompt deliveries. GET IN TOUCH WITH US!

TEST WHEEL—Tell us the kind of job and size wheel you need. We'll be glad to send one without charge.

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There are GRINDLINS *too, as well as* Gremlins

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just so, devilish little Grindlins tease and hamper the precision grinding machine operator.

"Your wheel is too soft, buddy," gleefully chirps the Grindlin. "Too soft, nix," says the voice of experience. "I true it more frequently because it has worn down to a smaller diameter."

"Ah, I've made your wheel glaze," he taunts. "True enough, you young imp" is the retort, "but I'll just increase the work speed, then watch it cut."

Think this over: Why be heckled by Grindlins while production lags. Norton engineering experience has met up with all their tricks that slow production and impair finish.

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Behr-Manning Division—Troy, N. Y.

NORTON ABRASIVES

Aviation People

JOSEPH R. HORTON, who has been general manager of the aircraft and engine overhaul divisions and superintendent of maintenance of the six flight divisions of the Embry-Riddle Co., has been appointed vice president. And **STERLING W. CAMDON, JR.** is new general manager of the company's landplane base. He formerly trained U. S. Army Air Force cadets at the Riddle Aeronautical Institute.

TWA Photo

MISS JANE HILL, former art director, has swapped her easel for a drafting board and T-square. She is the first draftswoman to be employed in the engineering department of TWA.

A. OGDEN PIERROT, former chief of engine production planning for the aircraft production division of WPB, will direct the new Washington office of McDonnell Aircraft.

CAPT. WALTER E. ALLEN joins Pan American Airways' Eastern Division as airline inspector. He previously served as pilot on eastern division routes and as airport manager at Jamaica.

CARL FRIEDLANDER, president of Aeronca Aircraft, was elected to the new board of governors of the Aeronautical Chamber of Commerce of America at a meeting of the organization. He is the only lightplane company representative serving on the board.

LT. JOY BRIGHT HANCOCK, USNR, is liaison officer, Bureau of Aeronautics and Bureau of Naval Personnel on matters concerning **WAVES,** assigned to the Aeronautical organization of the Navy. She was in charge of the Bureau's Editorial Research Section.

UAL Photo

JACK KNIGHT, one of the original mail pilots of the Post Office Department and subsequently one of UAL's veteran captains, is now helping to blaze new air trails in South America as a pilot supervisor in a special phase of Defense Supply Corps operations.

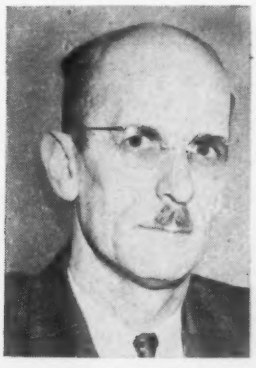
UAL Origmon Photo

On the fifth anniversary of her service on the airways, **MISS LUCILLE SCHROEDER** was named chief stewardess for UAL's eastern division and will supervise the work of 90 stewardesses. Since joining UAL in 1938 she has flown an even million miles.

DR. G. POTAPENKO, formerly a student of N. E. Joukovsky, developer of the first airfoil, later a professor at the University of Moscow, and since 1930 associate professor of Physics at the C.I.T. has been appointed Technical Director of Aircraft Specialties Co.

B. R. SHERRELL, formerly with Vultee, has been named general manager of the aircraft division of Willys-Overland Motors, where he will have complete charge of the company's rapidly expanding aircraft operations.

MISS DOROTHY MALLETT will teach celestial navigation and flight planning to company student co-pilots and Army co-pilots assigned to Braniff Airways. Instructor in parachute practices and navigation as well as celestial navigation.



J. R. CREAGER, Asst. AAF Inspector-in-Charge at Vultee's Inland Division and associated with the plant since its beginning, has been appointed Chief of the Inspection Department succeeding L. S. Shickle and **ERNEST WENIGMANN,** works manager of the modification center since its inception last year assumes new duties as works manager of the Inland Division succeeding B. R. Sherrell. Both men have been actively identified with the aviation industry for many years.

JAMES P. MURRAY, vice-president and Washington representative of the Boeing Aircraft Co., was elected president of the Aeronautical Chamber of Commerce of America at a meeting of the group's new board of governors.

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SPECIFICATION NO.

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APPEARANCE: Clear, Transparent, Homogeneous

DRYING TIME: Less than 1 hour to touch and 6 hours to handle.

TOXICITY: Nontoxic

LIFTING PROPERTIES: Does not lift with Lacquer or Enamel

VISCOSITY: At 25°C .50 to 1.00 poise

VEHICLE PROPERTIES: Excellent

FLASH POINT: Over 30°C (86°F)

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WORKING PROPERTIES: Excellent

FLEXIBILITY: Excellent

PENETRATING PROPERTIES: Excellent

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Recent Books

Tables of Data on Chemical Compositions, Physical and Mechanical Properties of Wrought Corrosion — Resisting and Heat-Resisting Chromimum and Chromium-Nickel Steels, *by Russell Franks and Francis L. LaQue. American Society for Testing Materials, Philadelphia. 43 pages, $1.25.*

Prepared for ASTM Committee A-10 on iron-chromium, iron-chromium-nickel, and related alloys, this pamphlet gives condensed data on material in widest commercial usage. There are two parts, wrought chromium steels (4-6, 8-10, 10-14, 14-18, and 23-30 percent chromium) and wrought chromium-nickel steels (25 percent chromium, 20 nickel).

Their mechanical and physical properties, chemical composition, forging and heat treating, creep characteristics, and short time tensile properties are analyzed in 21 compact tables and 26 charts and curves.

The Foreman's Handbook *edited by Carl Heyel. McGraw-Hill Book Co., New York. 410 pages, index, illustrations. $3.*

To give perspective, Mr. Heyel has called upon 17 specialists to describe, in as many chapters, the various aspects of the foreman's job. The object being to prepare the foreman, a representative of management, for greater responsibilities, the writing is expository and analytical rather than didactic. Among the subjects covered are control of quality and waste, planning and scheduling, time study, cost control, safety, fatigue, the background of scientific management, and labor legislation.

Photogrammetry, *by H. Oakley Sharp. John Wiley & Sons, New York. 129 pages, illustrations, tables, index, $3.50.*

Objects of this third edition are first to present "an exposition of the fundamental principles involved in both terrestrial and aerial photographic surveying" and second "a discussion of the application of these fundamental principles to map making."

In a style flavored with the brevity of an engineer's classroom notebook, Mr. Sharp outlines with mathematical precision the mechanics of earth-bound and aerial cameras, their uses and limitations, and the transference of their unemotional observations onto maps. Beginning with the terrestrial problem of perspective construction, he quickly takes the reader aloft on equations and diagrams and to the tasks of snapping the shutter and "making sense" of gelatin impressions brought back to earth.

"Aerial photographic surveying," he writes, "has now progressed to a point where it can safely be said that no survey of any size will be made without the aid of the aerial photograph." His description is not for box camera sightseers but for those who want the technical background of lens finding and negative interpretation.

Industrial Radiology, *by Ancel St. John and Herbert R. Isenburger. John Wiley & Sons, New York. 298 pages, illustrations, index, $4.*

Nine years' progress have not only necessitated revisions and the addition of material on equipment and accessories in this second edition but also a more inclusive title. Industrial radiography, "the study of conditions within materials used for industrial purposes by means of photographic records," has now become industrial radiology, "the entire science of these conditions as disclosed by x-rays and gamma rays."

The authors are pioneers in this field. Dr. St. John launched in 1925 the first industrial x-ray laboratory and with Mr. Isenburger later developed a trailer test unit to be towed to the job. With this practical perspective they first present a simple history of developments in radiology from Roentgen forward. The big year was 1912 when Coolidge introduced a new tube which "completely revolutionized radiographic technique." From here the authors trace, with brief and facile detail, discoveries which have culminated in apparatus ranging "from 5-kv. Grenz rays for the examination of paintings to 1,600-kv. machines for large steel structures."

These historical notes are but stepping stones to the meat of the book: The principles and operation of industrial testers. Illustrations, diagrams, and electrical circuits explain the total testing process—the nature, properties, and effects of x-rays, tubes, generators, and their installations, interpretation of plates, and finally operating and cost data. Tables, charts, and a bibliography of 1,314 items make this a comprehensive exposition of practical facts for the testing engineer.

Engineering Drawing, *by Leon Marr Sahag. Ronald Press Co., New York, 394 pages, appendix, index, $2.75.*

General introductory text for high school students beginning with the proper use of various pencils and drawing instruments, progressing to the intermediate subjects of steel structural and working drawings, and finally to the advanced problems of jigs and fixtures, elementary machine design, and patent drawing.

The Command of the Air, *by Giulio Douhet, translated by Dino Ferrari. Coward-McCann, Inc., New York. 394 pages, $4.*

This is original source material on the heated discussion of the power of planes to conquer and the need for independent air forces by the Italian who first brought up these subjects in 1909. His preachings and writings from then until his death in 1930 are collected here in four books: *The Command of the Air* (1921), *The Probable Aspects of the War of the Future* (1928), *Recapitulation* (1929), and *The War of 19—* (1930).

The first book contains the essence of Douhet's reasoning:

1. "Viewed in its true light, aerial warfare admits of no defense, only offense."

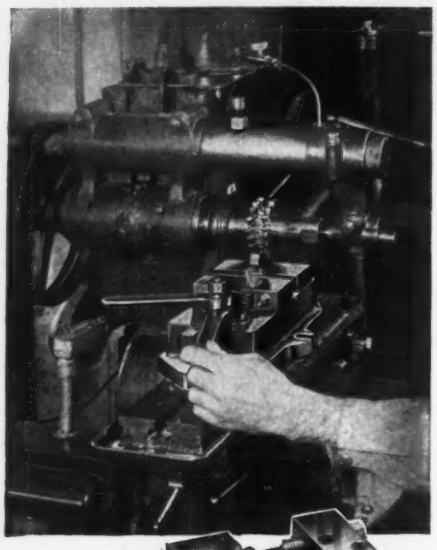
2. "To have command of the air means to be in a position to prevent the enemy from flying while retaining the ability to fly oneself . . . to be in a position to wield offensive power so great it defies human imagination. It means to be able to cut an enemy's army and navy off from their bases of operation and nullify their chances of winning the war."

3. Aerial force capable of conquering command of the air" is an "independent air force" composed of combat planes sufficient to protect bombers which can raze their target on the first trip and prevent checking the initial damage by the use of gas.

4. Army and navy auxiliary aviation are worthless and harmful because they cannot keep command of the air and dilute the strength of an independent force which could.

This independent force can attack with such sudden effectiveness that a war will be won in a few days. This the Germans proceed to do against a Belgian-French alliance in *The War of 19—*, which is Douhet's detailed preconstruction of the present struggle.

Several arguments can be advanced for the failure of this prediction of instantaneous demise. First, the high commands don't believe it—not even the Germans, who ordered the infantry to follow the *Stukas* through Poland and dropped parachutists on Greece. Second, Douhet's surmise that anti-aircraft would be the only opposition from the ground neglected the fact that fighter planes could and have prevented bombers from pulverizing resistance.



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Adaptable to many milling, drilling, tapping and assembling jobs.

Precision built for accurate work.

Sliding and stationary jaws precision fitted.

All working parts (except base) hardened, ground steel.

Base made of fine grained, well seasoned iron for heavy duty.

Guaranteed to be exactly as represented or no sale.

Three sizes: 4", 5" and 7".

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HARTFORD, CONN.
ESTABLISHED 1900

And third, as Douhet complains, aviation servicemen are apt to overemphasize their own specific branch.

Sea-Flyers, *by C. G. Grey. Faber and Faber, London. 256 pages, illustrated, 7/6.*

Thirty years an editor in British aviation publishing (of *The Aeroplane* until 1939 and for a time of *Jane's All the World's Aircraft*) have given Charles Grey a front-row view of his country's aircraft progress. Here he records his observations—sometimes caustic, again effulgently generous—on the services which have developed into the fleet air arm and coastal command. His story is neither definitive nor personal history but a combination of fact and reminiscence on politics, planes, and people.

For official stumbling blocks, myopic admirals, and bureaucrats, he has no use. (He suspects the bureaucrat to be related to the Spanish *burro,* little ass.) But two years of lend-lease have mellowed the judgment that "to order American aeroplanes of any sort is an imbelicity." Grey now finds that Lockheed *Hudsons,* about which he once wrote an obstreperous political caption, have "turned out to be much better value than they were expected to be." And he calls Glenn Curtiss "the father of all flying boats" who "quite definitely has the credit of being the first person to fly off and onto the water deliberately." Sandwiched between sections on British developments are several chapters on American transatlantic and military flying boats.

Young America's Aviation Annual 1942-1943, *edited by Frederick P. Graham and Reginald M. Cleveland. Robert M. McBride & Co., New York. 254 pages, illustrated, $2.50.*

The past year's progress in naval, military, civilian and commercial flying, production, and training is here outlined in simple, uncontroversial style amidst profuse and effective photographs. Young people are thus provided with a clear resumé of the facts. The chief military lesson of the year as pointed out by the book:

"Strategically, tactically and from the point of view of supply, the air arm has become the dominant arm and is gaining in relative importance. Pure, raw air power is a terrible and devastating force. But by itself, unless completely unopposed, it can hardly force a military decision. Properly employed with ground or naval forces, it is almost irresistible."

When the irresistible has pulverized blatant brutality, youth, which has helped win the decision, has another, thrilling challenge. Says Vultee Vice-President Hugh Fenwick: "The air routes of the world, some of them already established, will change trade, commerce, and all international relations to a greater extent and will do it in less time than have all other transportation changes in history combined. And they will do it in our lifetime—quickly."

The Fight for Air Power, *by William Bradford Huie. L. B. Fischer, New York. 310 pages, illustrated, $2.50.*

Much in the manner of Maj. Seversky, Mr. Huie champions the brute persuasion of wings alone and pours glib, retrospect criticism upon all those who didn't—according to his own broad generalizations—see it the same way during the years immediately past.

Airplane Design Manual, *by Frederick K. Teichmann. Pitman Publishing Corp., New York. 440 pages, diagrams, bibliography, index, $4.50.*

Specifications of the component parts of modern passenger planes—cockpits, cabins, instruments, fuselages, etc.—lucidly explained for students, engineers and draftsmen studying to become professional designers.

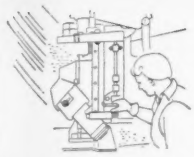
Aircraft Engine Trouble Shooting Chart, *by Andrew Wallace. Norman W. Henley Publishing Co., New York, 75¢.*

Large chart lists noises and symptoms, probable troubles, causes, and remedies of "ills" of aircraft power plants. Smaller related charts, supplying twelve classifications of faulty operation, give further breakdowns of trouble shooting.

ANC-5, Strength of Aircraft Elements, *issued by the Army-Navy Civil Committee on Aircraft Design Criteria.*

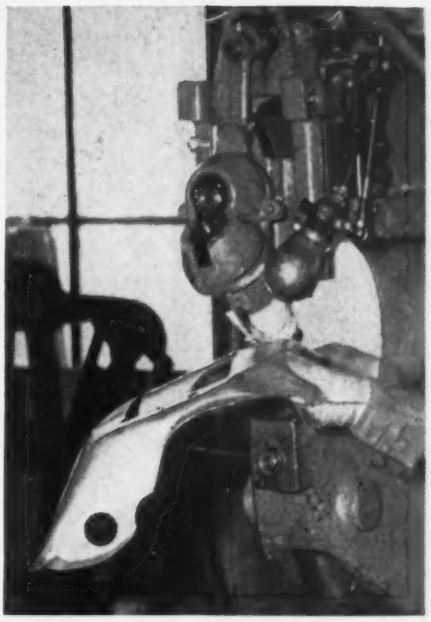
Among the additions to this revised engineering bulletin, listed as CAA safety regulation release No. 141, on strengths of commonly used materials and formulas for calculating them are several margin of safety expressions for combined loading, a figure on interaction curves to determine the margin of safety in elastically buckled flat panels, tables on mechanical properties of corrosion resisting stainless steel sheet and strip material, figures on stainless steel tangent moduli values, curves showing approximate hardness vs. tensile strength of carbon and low alloy steels, and tables on strength data of flush rivets. Changes have been made in the mechanical property tables of aluminum and magnesium alloys. CAA invites engineers for comments and suggestions regarding this work.

Women Are Operating QUICKWORK Rotary Shears



Fast cutting of steel, or dural, or stainless plate and stampings is being done every day by women operators in a number of leading aircraft plants. The simplicity of operation and accuracy of control of the Quickwork-Whiting Rotary Shear make possible accurate production at cutting speeds up to 40 feet per minute.

The Quickwork Shear is a versatile machine—saves space, time, and labor. It cuts straight lines, narrow strips, circles, and irregular shapes; forms flanges and joggles. Available in 12 standard models; capacities up to 1" mild steel. Write for bulletins and information.



Above: Close-up of flash trimming operation on a special alloy stamping of an airplane part.

Below: Woman operator handles accurate trimming operation on a curved aircraft stamping.

Photo courtesy Douglas Aircraft Co., Inc.

QUICKWORK-WHITING DIVISION

WHITING CORPORATION

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Other Quickwork **TIME SAVING** Metal Working Machines

Stamping Trimmers
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The Aviation Industry Is Served by Whiting Corporation with Cranes • Machines • and Matched Maintenance and Handling Equipment

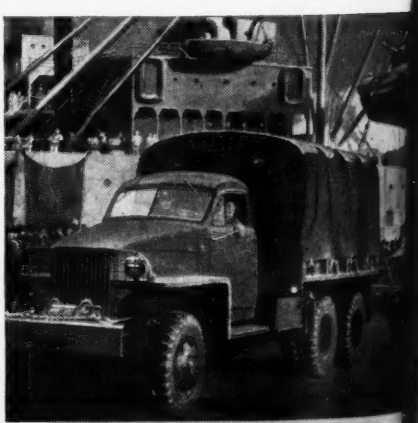
Studebaker craftsmen again give "more than they promise"

The devastating bombing power and matchless fighting power of the Boeing Flying Fortress make comforting daily items in the war news. Much of the flying power for this invincible dreadnaught of the skies comes from Studebaker, long regarded as one of the world's foremost builders of motor car engines.

Studebaker, America's oldest manufacturer of highway transportation, is privileged to collaborate with Wright, America's oldest producer of airplane engines, in this vital assignment. And Studebaker is also building much other war matériel including tens of thousands of big, multiple-drive military trucks for the forces of the United Nations.

Today, as for generations past, Studebaker craftsmen make their watchword—*"give more than you promise."* Every Studebaker employee is justly proud of the achievements of his organization in the arming of our Nation and its Allies.

BUY U. S. WAR BONDS



War Trucks for the United Nations! Studebaker, famed for years for dependable transportation, has now become one of the largest producers of big, multiple-drive military trucks for the forces of the United Nations.

Studebaker BUILDS WRIGHT CYCLONE ENGINES FOR THE Flying Fortress

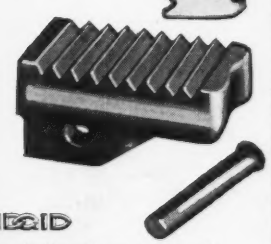
KEEP EVERY TOOL IN THERE *Fighting*

Prompt Factory Reconditioning

- No Priorities Needed
- Thru your Supply House
- Big Savings to you
- New Parts Guarantee

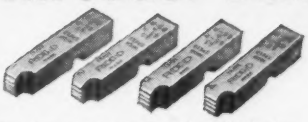
RIDGID Wrench Jaws

RIDGID Wrench Hookjaw



RIDGID Wrench Heeljaw with pin

RIDGID Threader Dies



Dies for RIDGID No. 65R Series

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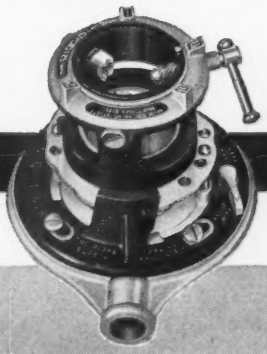

THIS IS NO TIME for tools to lie around waiting for repairs — like every gun, every tool is needed.... Collect all your old worn RIDGID Wrench Jaws and Threading Chaser Dies *now*, turn them over to your Supply House and order Factory Reconditioning. Service is prompt — *you don't need priorities!* Parts you send are carefully inspected to make sure they are worth reconditioning — we reserve the right to reject them if they can't be made good as new.... Remember: *only* RIDGID *trademarked parts accepted for this service.*

Quick Reconditioning of your RIDGID Wrench Jaws

Both hook and heel jaws are scientifically annealed in our automatic electric furnaces, same as new jaws • They are recut in the same machines and by exactly the same methods as used for new jaws • Jaws are then re-hardened like new • After final inspection, they are returned to you under regular RIDGID new parts guarantee of satisfaction.

Quick Reconditioning of your RIDGID Chaser Dies

Threader dies are accurately re-ground to original specifications. They are then inspected and tested and sent back to you under RIDGID new parts guarantee.

This service is available only in the United States.... Act now — keep every tool in there fighting to win the war.

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RIDGID

★ PIPE TOOLS ★

Fast-Working Tools for War... and the Busy Peace that's Coming

Airflow Visualization Opens New Research

(*Continued from page* 151)

escaping from a jet, sets up, as shown in Figs. 3 and 4, in the surrounding air columns of greater or lower density of air. Accordingly, the coefficient of refraction of these different columns must be different for the various parts within the air stream. Coming from one single central source, a bending of the rays of light must occur then, and a possible extinction may occur due to interference phenomena, thus producing shadows upon the screen.

This, together with the partial absorption of rays due to interference phenomena, is a necessary and sufficient condition for the establishment of the phenomena observed and recorded optically.

Fig. 9 showed a flow pattern of a narrow stream of air hitting a glass plate. And Fig. 10 depicts a narrow air jet hitting a glass plate under a 45-deg. angle (photographed through plate).

Working Hypothesis

It seems that standing waves are set up in that jet in a way comparable to the waves in organ pipes. Waves possibly caused within the jet persist within it after it has left its guiding nozzle. A reflection seems to take place at the boundary of jet-versus-air. These reflections finally (in dependency from the substantial variation of the air density) break up into segments which in turn are the root of the vortices that later on can be observed with the larger methods commonly known (smoke and oxide photographs in wind-tunnels).

As for the origin of the waves, the following consideration is made: We are dealing here with velocities that approach the velocity of sound, and sound waves themselves are subjected comparatively quickly to absorption. The mechanical shockwaves and end-waves, however, operate in a manner comparable to the waves in the trace of a bullet, such as were photographed originally by Ernst Mach and subsequently with a refined technique by von Cranz.

If a bullet in flight is photographed, for instance, by a spark of high intensity and of short duration, then it is found that it is accompanied during its flight by a stream of air waves that perhaps may be compared roughly to the bow and stern waves of a ship. Turbulences may be caused by the broad shockwave. The shape of these waves is constituted by the enveloping resultant wave which is composed of the sum of the bow waves. It is evident from Fig. 11 that the following relation exists between air velocity and speed of sound:

$$\sin \alpha = \frac{a}{w} \qquad (6)$$

a—Velocity of sound in air at a given density, temperature, moisture, content, and chemical composition (as may be caused by a different distribution of oxygen, nitrogen, and other gases in various layers of the atmosphere and stratosphere).

w—Velocity of the air stream relative to the obstacle. (From the angle α the relative velocity of air versus object and variations thereof can be measured.)

It will be readily understood that the same type of compression wave is formed whether the bullet moves through the air or whether air of high velocity impinges upon a quasi-stationary obstacle. The above formula may be inverted, therefore. Thus the following equation is obtained:

$$\alpha = \text{arc sin} \frac{a}{w} \qquad (7)$$

In other words, if air travels with a high velocity past an obstacle, then it may be stated that *the obstacle will be the origin of a soundwave which is in-*

(*Turn to page* 329)

HERE'S AMERICA'S NEWEST WEAPON IN THE BATTLE OF PRODUCTION!

NEW!

MODEL "47" SKILDRILL HEAVY DUTY ¼ IN. DRILL $36

Here's the tool you need for fastest, most accurate ¼ in. drilling in constant 3-shift production. Like the famous Model "45" SKILDRILL, it's small, compact, light for easiest handling—but it has *even greater power* for toughest jobs . . . *greater drilling speed under load* for more output per man!

Compact die-cast body, helical-cut gears and 100% anti-friction bearing construction assure smoother, easier operation. Extra-Powerful Universal Motor provides peak drilling speed up to ¼ in. in steel, ½ in. in wood. Available in 4 speeds (1800, 2500, 3500 and 5000 R.P.M.). Weighs only 3½ lbs.; only 7¼ in. long and 2⅛ in. wide. Ask your distributor to demonstrate how NEW Model "47" SKILDRILL will boost your production!

HERE'S THE FAMOUS MODEL "45" SKILDRILL

The *preferred* drill in every field for easy handling and fast precision production drilling. Thousands in use even by women doing day-long drilling on assembly lines. Plenty of power and speed to keep pace with today's stepped-up schedules. $32.50

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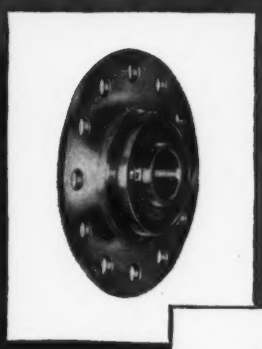
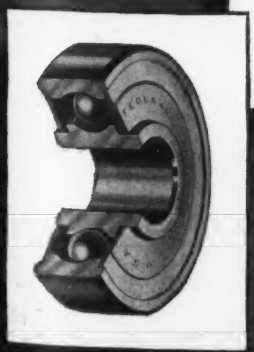
SKILSAW PORTABLE ELECTRIC TOOLS

★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★

Federal aircraft BEARINGS





For years, FEDERAL AIRCRAFT BEARINGS have been approved and used by leading manufacturers in the aircraft industry.

We have had wide experience in the production of QUALITY ball bearings for aircraft service and with the nation at war, this specialized skill is of vital importance in providing fine control bearings for the air forces of America.

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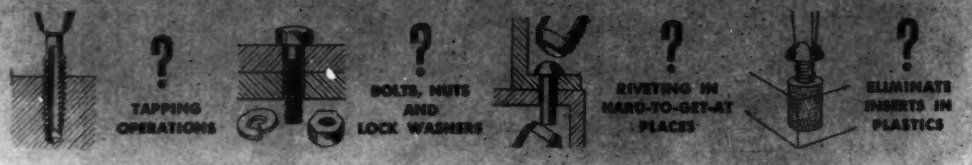
Question every fastening job



1,000,000 INSERTS SAVED!

PROOF IT PAYS TO CONSIDER PARKER-KALON SELF-TAPPING SCREWS FOR EVERY ASSEMBLY

Changeover to P-K Type "Z" Self-tapping Screws Eliminates Two Operations — Saves Critical Metals. Alert engineers of the United Transformer Co., New York, found that the P-K Hardened Self-tapping Screw would do the work of the brass machine screw, lockwasher, and tapped brass insert formerly used in the assembly of plastic units. The saving, not only of labor but of a sizable tonnage of brass, represented by this redesign on 1,000,000 units, was enthusiastically approved by the U. S. Signal Corps.

By questioning the efficiency of the fastening method in use, this war material manufacturer discovered a serious waste of precious man-hours, and corrected it by switching to P-K Self-tapping Screws. This job is typical of the large percentage of metal and plastic assemblies on which P-K Self-tapping Screws can provide greater ease, speed, and security.

Look for P-K Savings in Every Type of Assembly Operation. Whatever your product, and whatever material you are working with – plastics, die castings, sheet steel, aluminum, brass, or bronze – there's a saving *probable* with P-K Self-tapping Screws.

They eliminate costly time-consuming tapping and tap costs when replacing machine screws. They are easier to use and cost less than nuts, bolts and lockwasher assemblies. When they replace riveting and welding, they make equipment available for other needs. When used in plastics, they do away with costly inserts and slow molding.

Change to Self-tapping Screws Overnight. There's no interruption in production when you change over to P-K Screws. No special tools or skilled help are required.

War production badly needs all the work-hours P-K Screws can save . . . question every fastening job in your plant.

Call in a P-K Assembly Engineer to check over fastening jobs with you. He can help you search out *all* opportunities to apply P-K Self-tapping Screws. And, he'll recommend them only when they'll do the job better and faster. If you prefer, mail in assembly details for recommendations. Parker-Kalon Corp., 192 Varick Street, New York, N. Y.

SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

Give the Green Light • to War Assemblies

clined against the direction of airflow. (See Fig. 12.)

When a column of air moves with a high velocity, the same type of compression wave is formed that has been known to exist in the instance where a bullet travels through air. This is due to the fact that the absolute speed is irrelevant in this instance. What matters is the *relative velocity* between object and air.

The same laws that were found valid for investigating the behavior of projectiles relative to air can, therefore, be applied in the examination of stationary objects (such as parts of wings) that are exposed to quickly moving streams of air. Particularly it is permissible and appears promising to use analogous experimental techniques.

As is well known, air is not the uniform medium it appears to be. Thus, even minor changes in density can form at the high velocities with which we are dealing, the origin of disturbances.

Regardless of whether the object moves or the air moves, the relative velocity between the two is the same. Observations can, therefore, be made either in an airplane flying at great speed through comparatively still air or by air flowing at great velocity past a relatively stationary obstacle. This air jet may break up in segments (of expansion and reflection waves). These segments also may break up, thus offering the ideal conditions for an origin out of which larger, subsequent vortices may be generated.

Both from a viewpoint of scientific and of practical application to the design of aerodynamic structures, as well as for high speed air streams such as occur within the combustion mechanism of internal combustion engines, the new phenomena discovered and the new method of observation developed offer promising avenues of approach for the further investigation and development of this subject.

Modification Centers . . An American Military Innovation

(*Continued from page* 136)

Tooling, of course, in most instances is of the "quick and rough" variety; its goal is to get into production fast, but generally for only small quantities. Small, that is, when compared to the production of the manufacturing plant.

As quickly as possible, usually a matter of a few hours, tools are made and methods of producing the new parts or equipment are put into operation. Production, as in the early days of the industry, is necessarily almost exclusively of the handmade kind—"quick and a bit rugged," as we describe it. In one instance recently we went back 18 yr. for a method to make a part, producing it exactly as we did at that time by primitive methods long since abandoned.

At Consolidated Aircraft Corp.'s Tucson, Ariz., modification center, deliveries are flown in by company ferry crews from the manufacturing plant. Dispersed about the landing field adjoining the center's hangars, planes await assignment. When that is arranged they are taxied to the reception ramp at the head of the modification line.

Before they enter the line itself, and while still outside the huge hangar buildings, fuel, alcohol, and oil are removed and engines are drained, cleaned, and treated to prevent corrosion.

In the first stations of the line, all loose equipment, particularly that inside the fuselage compartments, is removed, tagged, and shuttled in a special box to the specified final station on the line, where it is reloaded when the same ship rolls through that station.

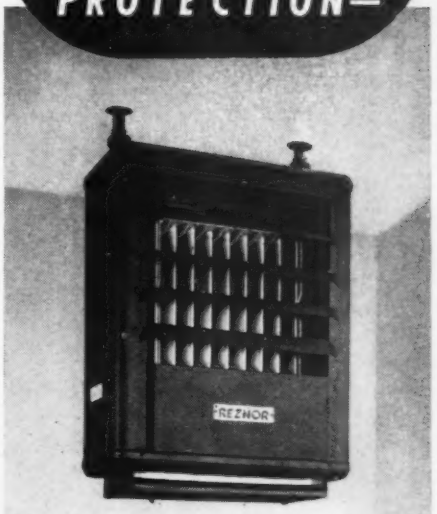
In one of the first stations, cowling racks made of plywood, with solid bottoms and ends, and slat sides 4 x 2 x 3 ft. in size, are fastened to the upper surface of the outer wings, two to each ship. Cowlings and parts removed so modification can be done, are placed in these racks and remain on the ship throughout the trip down the line. Each rack is divided into three compartments and these are specified for certain uses. In this manner, uniformity is achieved —parts are always found in the same place when needed, and the possibility of damage due to improper piling and jamming in the racks is avoided.

As on the assembly line of the manufacturing plant, work on the modification line is broken down into its logical segments, each to be accomplished at a given station of the line. In setting up the line—in fact in practically all phases of the work, whether in fabrication, installation, or reassembly — we have drawn upon the methods of the parent plant for ideas and timing.

Because of that we have found that holding to approximately the same interval of time per station as that allotted in the parent plants best dovetails our production with that of the source plants. However, the work done requires only about one-third the time, and one-fortieth of the manhours, required to build the plane. And those ratios will no doubt be changed as other units of the center are occupied and our personnel acquires greater skill.

Throughout the departments, nucleus staffs were drawn from other Consolidated plants. Around these we added staffs drawn from the community near which the center is located. Naturally, much of this personnel, with the excep-

REZNOR
UNIT HEATER PROTECTION—



FOR VITAL WAR WORKERS EVERYWHERE

TODAY we must protect America's men and women who serve on the production lines. Therefore, these people need heat-comfort so they can work more efficiently with less time off for illness due to fatigue, colds, coughs, etc. Reznor Gas Fired Unit Heaters provide the answer to this problem. Furthermore, Reznor Equipment may be installed at far lower cost with fewer men, and in less time than other tyes of heaters. They move more warm air during winter and provide greater air circulation during summer—more war production results.

Write today for literature.

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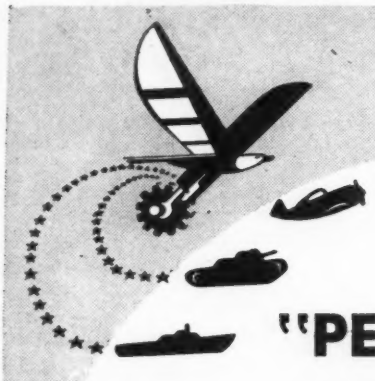


Before "PEARL HARBOR" AND *After* "TOKYO"

CURTIS was actively engaged in *Defense Work* before "Pearl Harbor." Thereafter, a constantly increasing volume of *War Activities* was taken on until we are now devoting all of our productive efforts to War Work for our Government and essential War Industries. We expect to continue on this basis until America dictates the peace terms in Tokyo.

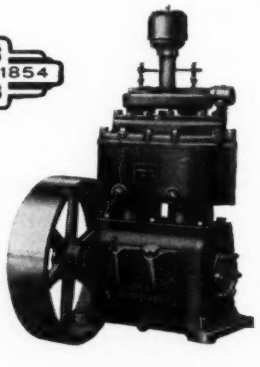
In World War I our engineering and designing ability and experience was recognized by the award to us of a contract for the manufacture of approximately two million (2,000,000) high explosive shell forgings. Our performance on this contract won for CURTIS the coveted Ordnance Department Flag, the emblem for "excellence," which flag is one of our treasured possessions.

Now in World War II our engineering ability and production facilities are again being called upon, first to design, then to produce some special equipment for one of the branches of the Armed Forces of the United States. This has progressed to the point where we are now tooling up, ordering in the material, and this *adjitional* productive activityMM becoming an accomplished fact.

Today's emergency is providing an even richer experience to add to that already accumulated in the 89 years during which CURTIS has been a successful and growing institution, and which will naturally be reflected in the products of the CURTIS organization after the war is won and when peacetime markets are again restored.

Curtis Pendant Air Hoist and I-Beam Trolley

CURTIS ESTABLISHED 1854 ST. LOUIS



Curtis Model C Water-Cooled Compressors, 3 to 60 H. P.

CURTIS PNEUMATIC MACHINERY DIVISION

of Curtis Manufacturing Company

1957 Kienlen Avenue, St. Louis, Missouri

tion of a few skilled mechanics, machinists, electricians, and the like, was inexperienced. However, they are rapidly learning the techniques of their jobs, and we do not anticipate any difficulties from that direction in maintaining the steadily increasing production rate we have planned.

As in all other plants these days, the labor problem boils down to: How many jobs can women handle? So far we have found the percentage about the same as that of the producing plants.

Along the assembly line we move the planes on their own wheels, by towing them (linked together by a single cable extending from nose wheel to nose wheel) with a tractor. Stations consist of fixed work stands arranged so the fuselages pass between them, and port and starboard wheels move through slots from which leaves in the floor of each stand have been removed. Because of the nature of the work, we can assign only about one-eighth as many workers as are used at average stations of the parent plant's assembly lines.

In the fabrication departments our workers have to be resourceful. A Jap fleet gathering at some distant harbor will not wait for us to figure out the most polished way to equip some bombers to go out and intercept it. Instead, it is our job to find a way to get the needed special equipment made and installed by the deadline set in the order. And we do it—often by forming parts on such machines as a 60-ton hydraulic press we bought from a wholesale automobile supply concern. With a die made of hard wood, and one accepted part as a pattern, we rush out the required number of parts.

Or, we cut stock with tin snips, hand form it over maple blocks, and burr the pieces with disk-type knife sharpeners picked up at the ten cent store. Parts requiring machining are frequently produced on small bench and tool-room lathes.

Taken as a whole, the modification center staff has to be not only resourceful, but must include a large percentage of people who are all-around craftsmen. When a ship leaves here it has to be ready to carry out its military mission.

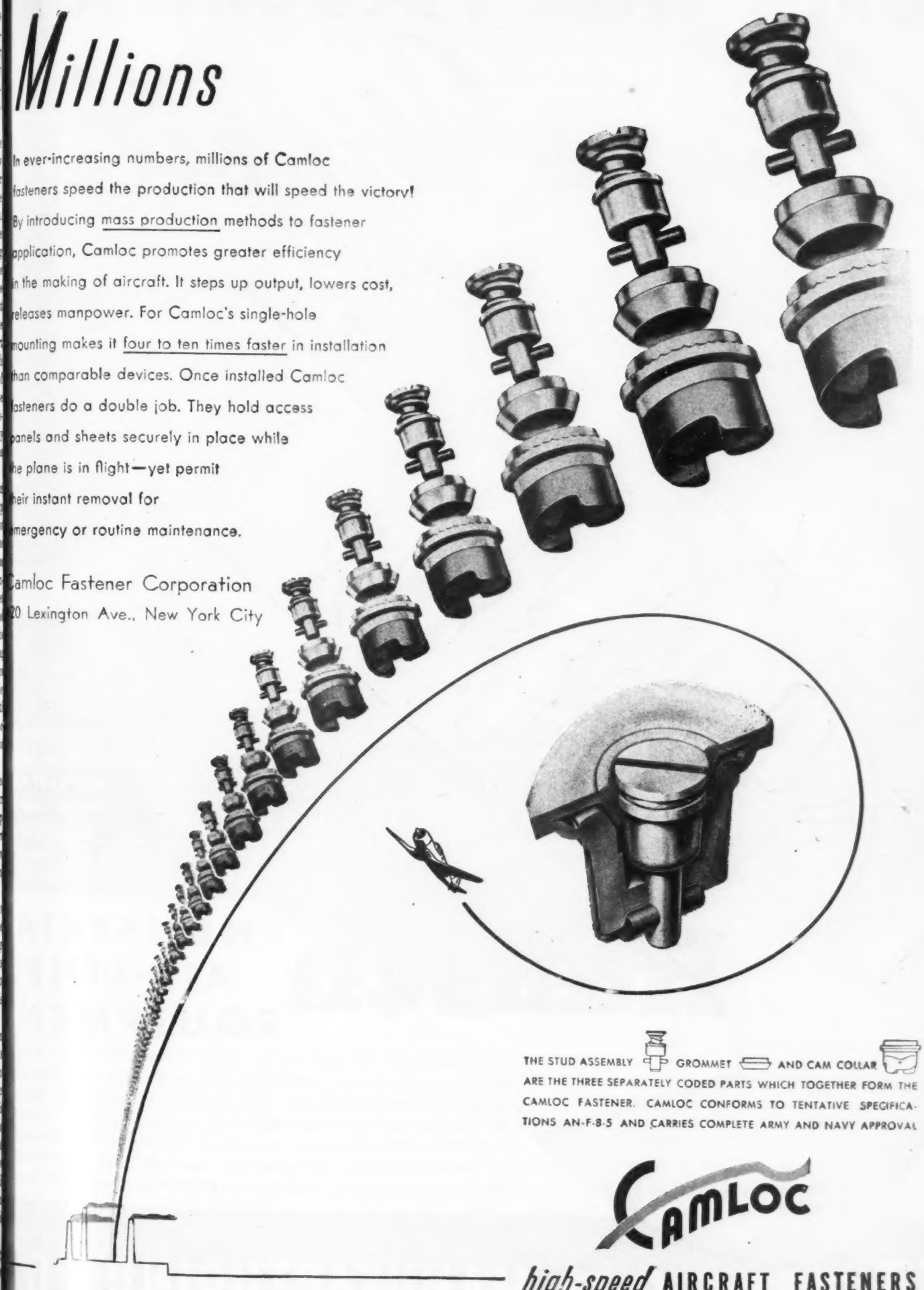
We look upon this modification center as an extension of the parent plant. Its work cannot be standardized, and its methods, equipment, and line arrangement will probably have to remain highly fluid. Gen. Arnold has said that our current heavy bombers are the "last of the small bombers." Whenever those bigger ones start coming along we will be able to handle them, too, because our arrangements were designed with such probabilities in mind.

When we finish our work, a military service ferry crew takes over and fly

Millions

In ever-increasing numbers, millions of Camloc fasteners speed the production that will speed the victory! By introducing mass production methods to fastener application, Camloc promotes greater efficiency in the making of aircraft. It steps up output, lowers cost, releases manpower. For Camloc's single-hole mounting makes it four to ten times faster in installation than comparable devices. Once installed Camloc fasteners do a double job. They hold access panels and sheets securely in place while the plane is in flight—yet permit their instant removal for emergency or routine maintenance.

Camloc Fastener Corporation
20 Lexington Ave., New York City



THE STUD ASSEMBLY GROMMET AND CAM COLLAR ARE THE THREE SEPARATELY CODED PARTS WHICH TOGETHER FORM THE CAMLOC FASTENER. CAMLOC CONFORMS TO TENTATIVE SPECIFICATIONS AN-F-8-5 AND CARRIES COMPLETE ARMY AND NAVY APPROVAL

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each plane to its particular delivery point. There it may be flown across an ocean, perhaps immediately loaded with ammunition and bombs in readiness for an attack on enemy objectives. Whatever its mission, it is ready for it.

The only American planes that fight go from modification centers. No longer do our field commanders say, merely: "Please send us some planes." Instead they ask for ships of specified types, equipped to meet climatic and tactical conditions of their respective theaters. And it is up to the "airplane tailors" in the modification centers to produce specialized airplanes for this specialized war—"Tomorrow's Fighting Planes Today"—one jump ahead of the enemy.

Absenteeism—What's the Problem?

(*Continued from page* 117)

4. Inadequate shopping and service facilities.
5. Inadequate child care facilities.
6. Inadequate health facilities.
7. Inadequate recreation facilities.

A survey shows that member companies of the West Coast Production Council have already taken steps to offset the universal causes, that additional steps will be taken soon and others are under study, with the same conditions holding true in the council's Eastern counterpart.

In the matter of fatigue, for example, all West Coast Council members had, by Feb. 15, instituted rest periods for both morning and afternoon to allow employees to get their "second wind." Many companies have started job rotation for employees doing particularly monotonous work. This step has reduced accidents by keeping the employees conscious of the possible hazards of new work. Extensive training programs for both supervisors and new employees have been inaugurated by all eight member companies. Labor piracy has been practically eliminated through a cooperative program worked out with the War Manpower Commission. Detailed record systems essential to getting at the causes have been installed, specialized anti-absenteeism programs are under way, and labor has been brought into active participation.

On the second major classification—individual employee problems—the companies also are aiding. Special facilities to meet requirements for women and older workers have been installed to curtail illness. Concentrated safety programs have not only reduced in-plant accidents, but have made employees more cognizant of dangers outside the gates. By working closely with local Selective Service, the companies have helped employees reach a better understanding of draft requirements which may be required of them. In-plant programs have helped educate workers to the necessity for winning the war. Through a program worked out with the Manpower Commission, labor turnover control has helped reduce job hopping.

The third major cause—community conditions—also has been tackled by management where necessary to cut absenteeism. Many plants have established housing bureaus to help employees find a place to live. Every company has a transportation service to help employees get to and from work, and problems of gasoline and mileage rationing were greatly reduced by the companies which set up a system whereby employees were allowed to get their ration books at the plants. Draft boards have been contacted through company offices to save employees an extra day away from work.

A special committee of the West Coast Council is working closely with community groups and government agencies to find a lasting solution to the problem of providing good care for children of working mothers.

Although no sure-fire method of providing convenient shopping and service facilities has yet been worked out, several communities have themselves taken steps to assure that workers on all shifts will be able to make necessary purchases during their free hours.

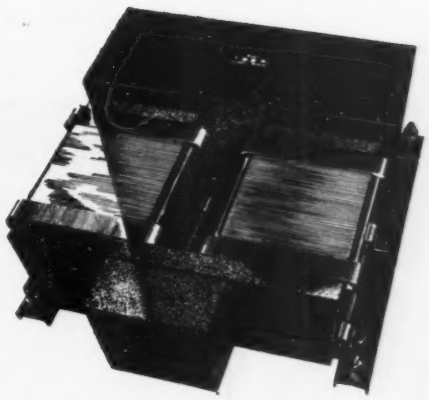
While the industry is working as a unit to combat absenteeism at the source, each company has found specialized problems that require specialized treatment, adopted to the individual plant, the survey revealed.

Beech Aircraft, for example, has tackled the problem through its joint labor-management War Production Drive Committee with a program of weekly awards ranging from War Bonds and stamps to "sterner" methods for habitual unauthorized absences. And Beech already had one of the best records in the country—since October it has averaged only 3¼ percent, but ¼ percent above the average peacetime rates.

Bell Aircraft reduced absenteeism even in the preliminary stages of use of a system based on "AWOL" cards placed in timeclock racks, telephone call forms from which records are compiled, post cards, etc. The system not only puts special absence-discouraging requirements on the employee when he reports back, but also provides a record of reasons for the absenteeism and types of workers who fall within the habitual absentee class.

Curtiss-Wright airplane division's

Industry steadies its "nerves"



FLUCTUATING line voltages are no problem in plants where Sola "CV's" take over. Power load surges may cause voltage variations as great as 30%, but the vital "nerve centers" of production lines continue to operate smoothly and with unerring precision.

Day and night, without care or supervision, Sola Constant Voltage transformers maintain positive control over electrically operated instruments and machines. These transformers are available in standard units with capacities ranging from 15 KVA, which can be used for an entire communications system, to the small 10 VA units for vacuum tubes. Special units can be built to meet unusual requirements.

Note to Industrial Executives: *The problems solved by Sola "CV" transformers in other plants may have an exact counterpart in yours. Find out. Ask for bulletin 12CV-74.*

Sola Constant Voltage Transformers

SOLA ELECTRIC CO.

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campaign has been projected as an integral part of its over-all War Production Drive, designed to reach the employee in an individual sense and in competition with his fellow workers.

Up to now, Brewster has handled the problem principally through bulletins, editorials, and letters from employees in the house organ, with extensive treatment of the problem being given in the union paper. Studies of absenteeism from the medical standpoint are being made, together with plans for labor-management committee participation in possible incentives, special awards, or other competitive means.

Consolidated's Southern California unit has initiated a unique new system for its "Work To Win" campaign under which the company allows every employee with a perfect four weeks' attendance record to participate in a prize drawing held each month. Through this drawing, $10,000 is distributed among the perfect record holders, with 73 prizes being given at each of the two plants. Top award is $1,000, with the second set at $500. Once each quarter, an extra $5,000 is added for extra prizes. The plan has approval of both the Treasury and Post Office Departments.

Douglas has a three-day clock control card system at its home plant. This system provides that the card will come to the attention of the Timekeeping Department when an employee has three consecutive unauthorized absences. The plant also has an Absence Control Department, with toll-free telephone equipment so that employees may call in when they cannot report for work. Through this department absences are checked and reasons listed.

When an absent employee returns to work, he is required to state in writing the reason for his absence, dates absent, whether or not a doctor was in attendance, etc. If the absence appears to be unreasonable, the employee is interviewed by a member of the Absence Control Department. In addition to an extensive control system, a "visual reprimand" is mailed to all unreported Saturday and Monday absentees. Throughout this plant, Douglas uses posters to show the number of employees absent in each department each day.

Lockheed handles its absentee control through the personnel records section. A telegram is sent to each employee on the second day of an unreported absence, appealing to his sense of duty and patriotism and urging him to telephone, stating the reason for absence. The telegram is signed by the employee's foreman, just as all contacts of this sort are handled by persons in the same department as the absentee. Separate lists of chronic absentees make it possible to carry the personal contacts directly to the greatest offenders, and continued chronic absenteeism sometimes results in dismissal. On the fifth day of unreported absence, the employee receives a registered letter stating that an immediate report must be made or employment will be terminated in accordance with an agreement with employee representatives. Visiting nurses are employed to call on persons absent for illness or injury more than three days.

Glenn L. Martin employees have reduced absenteeism by some 40 percent from last May to a point well below the national average. Recognizing the need for constant advancement in plans, however, the company is ready with an over-all plan which treats absenteeism as a community-wide issue; the means to solve it on such a basis are included.

North American has launched an intensive poster and chart system to present daily in graphic form the percentage of absentees, the result of such absences and the results which can be obtained if absences are eliminated.

Northrop has a central control system operated by its Production Control Station. Absentees unreported for three days are visited by a uniformed member of the Plant Protection force. Employees who are reported ill are called

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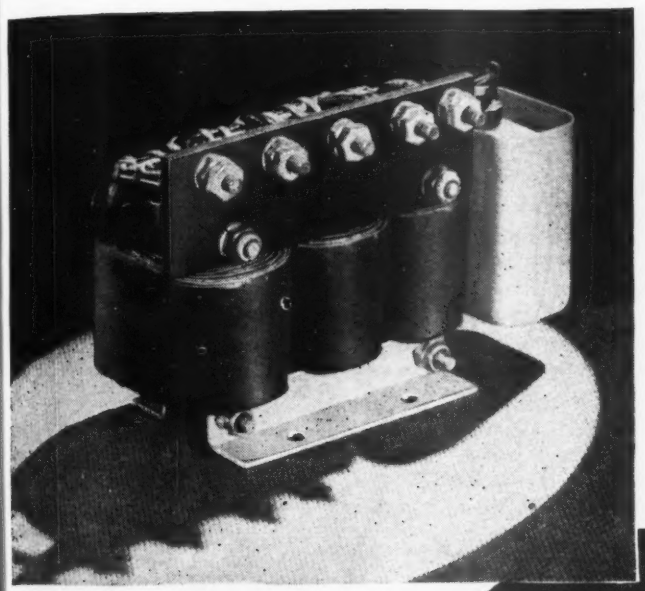
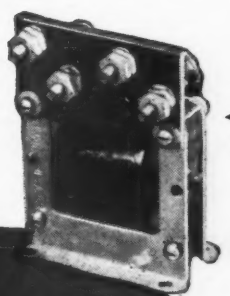


3-phase to 1-phase transformer—for the operation of such auxiliaries as the radio compass, bomb indicator lights, indicator rim lights. Eliminates the need for a single-phase winding on the generator. Permits reduction of generator weight; increases efficiency. Provides a single-phase, 115-volt or 26-volt power supply from a three-phase, 400-cycle generator *without disturbing generator phase voltages*. Ratings from 50 to 250 va. Weighs only $2\frac{3}{8}$ lb; size $3\frac{9}{16}$ by $5\frac{5}{32}$ by $2\frac{5}{16}$ in. (Weight and dimensions are for 150-volt-ampere rating.)



Indicator-light autotransformer—to provide a 30-va, 3.0/1.5-volt supply for bomb indicator lamps. Each unit will operate fifty-two 0.19-amp, T-$1\frac{1}{4}$ lamps. A 1.5-volt tap is provided for dimming the indicator lights, making possible the reduction of excessive brilliance in cockpit lighting when desirable, and the prevention of premature lamp failure due to overvoltage when only some of the lamps are lighted. Two ratings available for operation from a 115-volt or 26-volt, 400-cycle, single-phase supply. Weighs only $13\frac{1}{2}$ oz; size approximately $2\frac{1}{4}$ by $3\frac{1}{4}$ by $1\frac{1}{2}$ in. Adaptable to many other indicator lighting applications.

Enclosed ballast—for fluorescent lighting of aircraft instrument panels. Will operate four 4-watt MAZDA F lamps from a 26-volt, 400-cycle power supply. Lightweight (2.10 lb) and small size ($3\frac{1}{2}$ by $6\frac{1}{2}$ by 2 in.) make this unit particularly suitable. Designed for operation at any altitude and in ambient temperatures up to 60 C. Similar units are available for operation from a 400-cycle, 110-volt supply, and in addition provide a 3-volt, 10-amp (or 5-amp) supply for indicator and instrument rim lighting by means of a small transformer within the same housing.

Ignition booster coil—to provide a reliable, hot spark for starting airplane engines when the magneto speed is low. Coil cuts out of ignition circuit as soon as engine starts. One coil per magneto is required. Smooth, accurate, permanent adjustment of contacts is assured by a positive-lock contact support. Positive starting is assured by high, secondary output voltage and current. Operates on 12 or 24 volts, d-c. Weighs only 14 oz; size $3\frac{5}{8}$ by $2\frac{5}{16}$ by $3\frac{5}{8}$ in.

Inverter ballast (d-c to a-c)—for fluorescent lighting of aircraft instruments and indicators on training or other light planes. Operates four 4-watt MAZDA F lamps from a 12-volt or 24-volt d-c battery supply. Also provides 1.5 amperes for operation of eight 3-volt indicator lights. A low radio-interference level is obtained by the well-balanced electrical characteristics of the windings and by careful filtering. For operation up to 35,000 ft and in ambient temperatures from −15 F to 140 F. Weighs only $2\frac{1}{2}$ lb; size $5\frac{1}{8}$ by $5\frac{5}{8}$ by $4\frac{7}{32}$ in.

Yours for the Asking—*Complete data on how to do the job better by using transformers. Write for a copy of "Specialty Transformers for Aircraft." General Electric, Section A403-41, Schenectady, N. Y.*

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upon by a visiting nurse.

Ryan launched a realistic campaign last November, when it printed in the company magazine a chart showing absences through the week, with increases at week ends, labeled "Holidays for Hitler," "Complacency Week End," etc. Absenteeism of 9.05 percent was cut quickly to 7.66 percent. Since then the rate has been further reduced by additional charts and the installation of a card system for check-back against absent employees, requiring them to execute a form stating reason for absence. Underlying causes, such as ventilating systems which do not operate properly and may be a factor in causing colds, are being sought through plant studies.

Vega utilizes a system similar to that of Lockheed, setting the penalty of discharge after ten unauthorized absences.

Vultee has an absence control system which has been in effect for more than a year and has resulted in what is believed to be one of the lowest absentee rates in the entire aircraft industry—3.2 percent for men and 5.2 percent for women, or a mean average of 4.2 percent. Here all new employees are given a 2-hr. induction tour, including a 15-min. talk by the safety engineer. As an employee goes through the plant, the functions of each department are carefully explained and he is impressed with the importance of his own particular job to the entire production plan.

An absent employee is required to report within three days or his employment terminates automatically. Absentees are telephoned or, if unavailable, a telegram is sent. In order to return to work, an employee who has been absent must go through a lengthy procedure of passing the medical department and filling out a detailed form. Time required to fill out absence reports and visit the medical department is deducted from pay. These factors discourage absenteeism by making it annoyingly complicated to get back into routine work again. Hospitalized employees are sent greeting cards expressing the company's hope that the worker will soon be able to return to work.

Other studies aimed at reducing absenteeism now being made by the West Coast Council include possible changes in paydays; re-arrangement or modification of working hour schedules; and vacations as attendance incentives.

A survey by the East Coast Council showed that steps to curb absence include efficient maintenance of employee records to differentiate between voluntary and involuntary absenteeism; determination of individual reasons for being absent, and, wherever possible, elimination of contributing factors; studies of housing, transportation, and shopping facilities; plant, community, and national informational aids which promote education of workers to the importance of their jobs; and other information and remedial actions which would affect particular plants or communities where plants are located.

These studies, coupled with the work already done and projected by the individual companies as well as the councils, give every indication that absenteeism—at least in the aircraft industry—will be reduced to a minimum.

Postwar Preview of European Airways

(*Continued from page* 202)

a prospective airway system of Europe, with radio-range stations, a unified teletype system for hourly spot-weather and six-hourly weather-map reports, frequent radiosonde ascents, and airway traffic control.

Main Arteries Cited

Six main arteries for air traffic might well be expected to form the nucleus of airlanes over the European continent:

1. The Northern Atlantic artery, entering the European continent through Ireland, England, and Norway.

2. The Arctic artery which will connect the American west coast directly with Eastern Russia and Southern Asia.

3. The Siberian artery, connecting Europe with the Far Eastern Pacific coast.

4. The Near-East and India artery, a life-line for our forces in the Indian area.

5. The African artery, connecting Europe with East and South Africa.

6. And the Southern Atlantic artery, connecting Europe with the North and Central American continents and islands via the Azores and with the South American continent via the Dakar-Natal airway.

North Atlantic Branches

The Northern Atlantic artery, upon reaching the Northwest coast of Europe, should most logically branch out in four directions:

A. An airway whose first port of call would be Nidaros (Trondhjem) and which would create the shortest air route from New York to Leningrad, Moscow, Stalingrad, and points southeast towards India.

B. An airway via Rejkjavik, Iceland, Bergen, and Oslo which would serve East-Central Europe with one branch continuing eastward to Riga, Minsk, Kiev, and Rostov, and another going in a more southerly direction through

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Gdynia, Warsaw, Lwow, and Odessa, with both branches uniting again in the Caucasian oil region and joining the Near-East and India artery at Krasnovodsk on the Eastern shore of the Caspian Sea. A third branch would go almost due south to serve Berlin, then veer southeastward to Prague, Bratislava, Budapest, Bucharest, Ankara, Baghdad, and continue to India along a more southerly route.

C. An airway to Central and Western Europe (by-passing London and the congested airways in the London-Paris-Rotterdam triangle) to serve Amsterdam, Frankfort-on-the-Main, Trieste, Salonika, and connect with both the Indian and the African arteries.

D. The main New York-London airway whose numerous ramifications would cover Western Europe and North Africa. One of these branches would by-pass Paris and continue to Cape Town via Barcelona, Algiers, and the Belgian Congo.

The Arctic artery (No. 2), the most hypothetical link in this prospective airway system, represents the shortest air route from the American West coast to the industrial region of the Urals and to India. It reaches the Arctic coast of the USSR near the 60th meridian and continues in a general southerly direction.

The Siberian and Indian arteries, of the greatest importance in the war with Japan, reach Europe through the Ural region and the southeastern European airways already discussed as outlets of the Northern Atlantic artery. The airways to Africa have also been briefly mentioned.

East-Southwesterly Flow

The general flow of air traffic across Europe in an East-Southwesterly direction may follow five main routes:

First, the Atlantic Seashore route, from Leningrad to Lisbon, via Southern Scandinavia and London.

Second, the Baltic-Biscay route, via Riga, Gdynia, Berlin, Paris, Bayonne, Madrid, Gibraltar, and Lisbon.

Third, the Central route, a continuation of the main Siberian artery, serving Moscow, Warsaw, Prague, Nuremberg, Stuttgart, Lyon, Toulouse, and the aforementioned Iberian centers.

Fourth, the Ukraine-Mediterranean route, connecting Southern Russia with Budapest, Trieste, Venice, Milan, Barcelona, Gibraltar, and Lisbon;

And fifth, the main Mediterranean airway from Istanbul to Salonika, Catania, Tunis, Algiers, Oran, Casablanca, and Dakar.

All these East-Southwesterly airways would conveniently connect with the transoceanic services across the Atlantic at Lisbon and Dakar.

A system of regionally and locally important additional airways will, of course, be needed to supplement this general air transport scheme. A peculiarity of these secondary lines, in agreement with previous European experience, will be the "leap-frog" character of certain airlines, that is, involving direct trips between important centers without intermediate landings. A direct schedule between London and Warsaw, for example, will be desirable, without intermediate landings at Amsterdam and Berlin. Creation of special by-pass airways will then be necessary in order to avoid local congestion.

Complexity of the European air transport situation during that interim following the collapse of the Axis in Europe and the pursuit of the war in the Western Pacific clearly reflects, in this brief discussion, but one of its phases. A quick and efficient reorganization of the European airways is vital for a speedy conclusion of the Pacific war, and it will save many years in the rehabilitation of prostrate Europe. A time will come when these war-born airways, reverted to purely civilian transportation, will knit more closely the ties between the European nations, so that they may find the way toward each other and toward a happier future.

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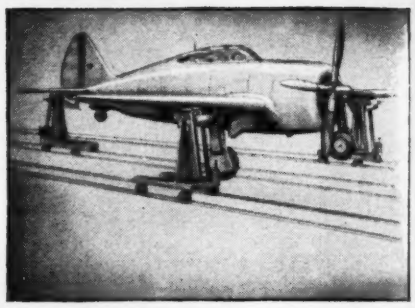
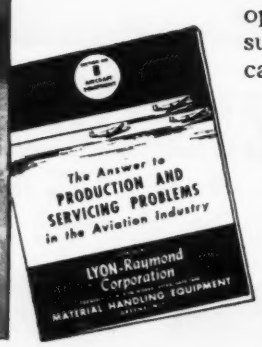
4. Hydraulic Spotting Dolly—expedites maneuvering of planes in limited space in hangars, factory floors or on Aircraft Carrier Decks.
5. Propeller Dolly—for transporting and storing propellers.
6. Portable Hydraulic Hoist—for positioning Superchargers in assembly line.
7. Portable Propeller Blade Rack—for transporting and storing propeller blades.
8. Hydraulic Elevating Work Stand—places workers at proper height for their jobs.
9. Hydraulic Elevating Hoist—for elevating crashed planes.
10. Cradle Type Trailer—for transporting damaged planes.



For each plane, there are three hoists—one for each wing section and one for the tail section.

Boom elevates to 23'-5½"; swings 1 ft. either side of center. Speed of lift: 12' per minute.

Body may be raised to full elevation with extraordinary stability.



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This may look funny—

BUT IT'S MIGHTY SERIOUS

Current news reports apply a fun-making name to some mighty serious troubles that have bothered production, assembly and maintenance men right along.

These reports say that army ground crews are cursing the "MECHLINS," second cousins of the notorious "Gremlins." "Mechlins" are trouble makers for men who handle wrenches.

Shown here is that troublesome Mechlin, "SPECIALITUS," who provokes a mania for making special tools for every odd job whether necessary or not. Blackhawk's completely interchangeable socket wrenches put this guy out of business. No need to waste time making special wrenches — when one standard set of Blackhawk Socket Wrenches makes *thousands* of combinations. Most important, Blackhawk's exclusive Thumb-Release "Lock-On" clicks each combination into a solid tool! Many other features combine to make Blackhawk Socket Wrenches the modern answer on complicated assembly, service and maintenance jobs.

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Here's a tight-squeeze job for which Mechlins would tempt the design of a special tool. This is a waste of time and expense when a standard Blackhawk Socket Wrench combination will handle the job better, faster and easier.

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Consolidated Subcontract System Coordinates Schedules

(*Continued from page* 197)

rudders, elevators, gun turrets, complete outer wing panels, wing-tips, ailerons, wing flaps, leading edges, bomb doors, fuselage side-panels, complete power plant installations, pilots' enclosure, ladders, seats, bunks, tables, galley equipment, instruments, molded and laminated plastic plywood parts, and the landing gear, to mention the larger items. Practically the same progress has been made in subcontracting the components of the *Catalina* and *Coronado*.

In order to correlate all this out-plant manufacturing, several problems must be faced. The first is that a premium must be paid by the prime contractor. The subcontractor must learn to make the component. He must also have a profit. In-plant operations, standardized and efficient after creating many units, will require far less man-hours than will be used for the job in the plant of a subcontractor just beginning.

The prime contractor must know how many more man-hours the subcontractor will consume. For instance, if Consolidated did not receive reports at least once a week from all subcontractors, it would have to face re-negotiation of contracts on the *Liberator*, *Coronado*, and *Catalina* without an accurate estimate of man-hours consumed on the aircraft, and therefore without an accurate estimate of cost of the completed planes. This is particularly true under the fixed-price contracts where the exact costs must be known, as a very small percent of error on a backlog of several billion dollars might result in the loss of millions of dollars.

Consolidated is meeting this problem through the use of log-log charts containing both cumulative and non-cumulative man-hour studies with a "learning curve" which allows for increased man-hours per unit in the work of the subcontractor due to his inexperience. The subcontractor's proposal is broken down to direct man-hours and plotted on a log-log chart to show a comparison of Consolidated's standard time for the shop, as well as the actual performance on the job, so that the subcontractor's proposal can be intelligently analyzed and his learning curve projected. If the differential of the subcontractor's average man-hours for the subcontracted quantity is a reasonable differential over Consolidated's standard time or performance, the proposal is accepted.

As an example, one log-log chart shows that the time consumed by in-plant operations on a certain part is 70 hr., against a lot placed with the subcontractor, who predicted an average of 105 man-hours per unit due to the learning curve which every subcontractor must necessarily go through before hoping to attain the efficiency of present construction at Consolidated. Cumulatively, on the completion of an equal number of units over a period of weeks, it was shown that in-plant man-hours totalled only 175,000 hr., against 230,000 hr. for the subcontractor. With these figures at hand, it is obvious that forthcoming production on the part of the subcontractor can be estimated with reasonable accuracy when definite man-hours per week are assigned to the job. This system of charting was introduced by the supervisor of subcontracting last year.

Suppose a subcontractor is falling below his anticipated production. Obviously, charting does not correct the condition, but it affords reasonable accuracy in predicting, ahead of the scheduled date, whether or not that subcontractor will make delivery. Action can usually be taken to correct the trouble encountered by the subcontractor. Consolidated must also keep a check on its own responsibilities to the subcontractor, and for this another chart.

(*Turn to page* 345)

We're Both on the Spot ... Brother!

IT'S all one battle—the roaring dive of a squadron on the target and the precise thoroughness of laboratory and precision manufacturing facilities brought to bear on the one big objective —MORE PRODUCTION!

The battle begins here—*Your problem* is to get even the toughest jobs done ahead of schedule. *Our problem* is to supply the *quality-controlled* materials and methods to meet the production finishing demands of those jobs.

That puts us both on the spot—so, let's fight and work together. Today, as always, we are interested in helping you solve your finishing problems, be they metal, plastic or what-have-you. A laboratory research staff and facilities second to none, working closer than ever with McAleer engineers in the field, are developing new materials, new methods daily, any one of which may be just the solution to your toughest finishing problem.

So, step *off* the spot—let us make a practical demonstration of what McAleer On-the-Job Advisory Service can mean to you in terms of better finish, increased production at less cost. You will not be obligated.

McAleer MANUFACTURING CO.
Quality-Controlled Finishing Materials
ROCHESTER, MICHIGAN

Tin fish swim only on the home stretch

Aerial torpedoes have to swim only a few hundred yards on their own power. But first they must be flown hundreds of miles to get within striking range.

How far the tin fish can be carried depends on the range of our planes. Range comes from extra power per pound of weight, and therefore is largely a matter of gasoline quality. With high-octane gasoline available, our engines were designed to produce more power—more miles—per gallon of fuel.

The "fighting grade" gasoline which the American petroleum industry is turning out in vast quantity for our Army, Navy and Allied planes is a triumph of chemical and engineering ingenuity. Every gallon contains Ethyl fluid to boost the already high octane rating still higher; to put in an extra punch.

Some 4000 people today are employed in the manufacture of Ethyl fluid. To all of them the sight of a plane in the sky, the sound of an engine overhead, is a reminder that their time and skill are needed.

ETHYL CORPORATION

Chrysler Building, New York City

Manufacturer of Ethyl fluid, used by oil refiners to improve the antiknock quality of aviation and motor gasoline.

Vega Seals Riveted Fuselage Seams of the Boeing Flying Fortress

With PRESSTITE Extruded Sealing Compound Tape

Vega Aircraft Corporation is using Presstite Extruded Sealing Compound Tape to seal the riveted fuselage seams of the Vega-built Boeing B-17F Flying Fortress.

Like many other aircraft manufacturers, Vega has found this Presstite sealing compound provides a time and labor saving method of getting a better sealing job accomplished in the fastest possible time. The fuselage of the B-17F is sealed to keep out dust, dirt, rain, and air—providing cleaner, more comfortable compartments for the bomber crew.

This is only one of many uses of Presstite Sealing Compounds by the aircraft industry. Others include the sealing of:

- Integral Fuel Tanks
- Drop-Off, Expendable Fuel Tanks
- Intercoolers and Airducts
- De-Icer Tanks
- Gun Turrets
- Synthetic Glass Enclosures
- Instruments
- Seaplane Floats

PRESSTITE SEALING COMPOUNDS

Every Presstite product has been thoroughly tested — in the laboratory as well as under great stresses and in the most trying conditions of flight.

Let Presstite help to solve your sealing problems. Send us detailed information as to your requirements and let our laboratory engineers recommend the best sealing compounds for your particular needs.

PRESSTITE ENGINEERING COMPANY, 3910 Chouteau Avenue, St. Louis, Mo.

is used which shows whether or not the company has fulfilled its obligation on schedule. Has all engineering information been supplied and, if not, what percentage? Has Consolidated supplied tooling information, production tooling or master gages, fabricated parts, and have material shipments been made on the scheduled cycles? Answers to these questions, found on these charts, are the first step in correcting conditions in the field.

If a subcontractor's production is not meeting that anticipated schedule, the deceleration in delivery must be remedied by the prime contractor in his own plant—he must accelerate his own production and those units so that an adequate number of parts will be created in-plant to keep from starving the assembly lines. It is evident, then, that any tendency to fail to meet quotas by the subcontractor must be known to the prime contractor 60 to 90 days in advance, and even further as the subcontractor first undertakes his operations.

This problem of acceleration and deceleration becomes more and more acute, and the operation must be timed with greater and greater accuracy, as materials become scarcer. Some time ago it was possible to keep well ahead of the assembly line by slow in-plant deceleration. This called for large stocks of materials. Today, however, exact quantities must be directed to both prime contractor and subcontractor to take care of certain definite periods and units of production, and any speeding up or falling off results in serious tie-ups.

While relatively simple charts on progress served well when only a small percentage of the aircraft was subcontracted, a more scientific approach for charting performance and anticipated performance has become mandatory. The magnitude of subcontracting and the high productive rate of major units cannot be trusted to casual observations and unrecorded statistics of the outside manufacturer's potential capacity or current performance. Specialization on subcontracting problems became necessary.

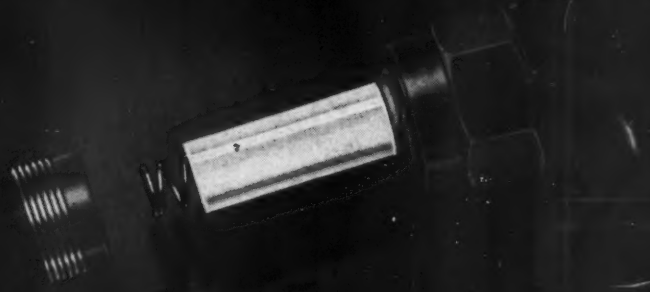
Consolidated foresaw this necessity for specialization even prior to Jan. 1942, when it became very evident that the combined material and purchasing department—top personnel of which handled subcontracting—was becoming unwieldy. The material department in its many sub-departments, including production control, contained more than 3,000 employees. It had been suggested that some phases encompassed by the department be segregated and established as separate units, reporting to the officer in charge of production.

When Charles W. Perelle, former general manager of Vultee, was appointed vice-president in charge of production, plans were immediately instituted which culminated in establishment of the subcontract production department. At the same time, a production control department, material department (including the purchasing department) and a traffic department (including the shipping department) were established as separate groups to report to the vice-president in charge of production.

The subcontract production department has a personnel of more than 150 and will continue to grow. The unit now contains coordinating engineers and tooling representatives, working together on tooling and engineering problems; field expediters; a staff of buyers, assistant buyers, and follow-up clerks; a production and scheduling group; material coordinators, mathematicians, and statisticians.

Responsible to the supervisor are two staff assistants. One concentrates on production problems and is also responsible for man-hour studies and shop loading; the other handles special assignments, reports to the Army and Navy, handles tax problems, arising on our property in the plants of subcon-

Auburn CERAMIC
SPARK PLUG CONNECTORS



A vital part on which every spark plug of every aircraft engine can depend — for constant contact.

Auburn Ceramic Connectors are *APPROVED* and *ACCEPTED*. Made by one of America's pioneers in the spark plug field, and nationally known since 1910 — an institution with complete, modern facilities for volume, precision production.

Made in two sizes as illustrated.

Inquiries invited from engine and harness manufacturers.

AUBURN SPARK PLUG COMPANY, Inc.
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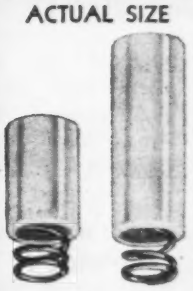
AIRCRAFT DIVISION
1180 Raymond Blvd. Newark, N. J.

ACTUAL SIZE



No. 1041 — 9/16"
No. 1099 — 1"

tractors, and also office problems.

Consolidated's system of letting subcontracts has been developed to a fine point. The first step is to compile a parts list breakdown, together with full details of the job, drawings, and process memoranda, and information on the availability of tooling—whether we can supply the tools or whether the subcontractor must obtain or build them. The company also outlines what master gages are required to attach the subcontracted assembly to its planes. This has to be built in Consolidated's plant and supplied to the subcontractor before he can check out his jigs.

In analyzing bids, prime consideration is given to the reputation and past performance of the subcontractor. Price, naturally, is important, but the company will not let a difference of a few cents per unit enter the picture when there is a wide difference in the character, equipment, and past performances of the bidders. Due consideration is given to our production schedule, and a notice of intent to subcontract is issued to the selected subcontractor, together with an actual schedule of the subcontractor's production requirements. This notice of intent also informs other Consolidated departments of the program being placed in effect, so that they may conform. This information includes the number of units to be made in-plant and the number to come from the new out-plant operations.

This fixed schedule shows the production and rate of acceleration from the subcontractor's plant and the deceleration in the Consolidated plant, together with the requirements of other home-plant divisions, for whom we might be subcontracting the same part. It also shows allocation of raw materials and finished parts made in the Consolidated shop and the subcontractor's shop to meet the proposed schedule.

An important phase of this is setting up the cycle of material time, as materials must be on hand when needed. The subcontractor needs them from 90 to 120 days before production. Later, as he gets into production and his performance has been actually charted, this time cycle may be cut to 60 days.

If the prime contractor's delivery schedule is accelerated by the war program, shop loading studies of the various subcontractors' plants must be made before it can be determined whether the schedule can be met. The man-hour studies, space allocation, shop facilities, and the availability of materials and parts, must all be given due consideration.

If the subcontractor's proposal indicates that too great a premium of man-hours would be required, it would be rejected and fabrication of the part would continue in our own plant. On the same chart a cumulative man-hour study is plotted to show the required man-hours per week which the subcontractor will require to perform the job. As the subcontractor progresses and reports cumulatively the man-hours expended, it can be determined whether or not he will meet the delivery schedule for the units produced at the man-hours allotted during his learning curve.

A careful training system is a part of the subcontracting program. As soon as the basic factors are known, personnel from the subcontracting plant are sent to Consolidated for a training period which may last from several weeks to several months. It has been consistently shown that such a plan lowers the man-hours involved in the learning curve.

Following familiarization with Consolidated technique by the subcontractor's workers, they are returned to him to do their jobs. Sometimes, as the subcontractor gets underway, a Consolidated man who is entirely familiar with the job is sent to the subcontracting plant to assist in getting the job quickly into production. This man must necessarily be entirely familiar with

共

和

Long ago, the Chinese with their genius for co-operation posted on trees and buildings these symbols, "Gung Ho." "Gung," "together" or "common." "Ho," "peace," "happiness," "working." "Gung Ho"—"Working together."

Two years ago, a Wyman-Gordon worker told this little story at a shop gathering, and soon thereafter "Gung Ho" began appearing on walls and machines, here and there in our shops.

Today, civilization calls to American industry for manufacturing miracles, miracles performed by the meeting of minds, working together as creative stimulus in production for gargantuan warfare . . . miracles that are more than the sum total of individual ideas evolving precise mechanisms . . . the working of heart, hand, mind, together in the creation of matériel for victory. Makers of vital forgings for **all American high-powered aircraft, for tanks, for countless tools of war, Wyman-Gordon men and women are "Gung Ho" minded.**

Night and day, in the quiet of planning, in laboratories where technicians find secret of steel, in the heat and glow of steel where giant hammers resound like the firing of great guns, strong men and valiant women are proving their might in war production, proud to follow in the spirit of the ancient Chinese who gave us "Gung Ho."

—And we of Wyman-Gordon realize "Gung Ho" will also be a component part in post war development, a practical force for the wider use of forgings—strength with less weight.

WYMAN-GORDON

WORCESTER, MASS. • HARVEY, ILL. • DETROIT, MICH.

K&E
REG. U. S. PAT. OFF.

HANDS OFF! Our costly, time-taking original drawings are always

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They stay in safe storage. We make all duplicates from **PHOTACT** *prints—let them take the beating*

Today's top-speed production requires as many as a thousand blueprints from one original drawing.

But pencil tracings—which most drafting rooms use today—are not sturdy enough to stand up under too many blueprinting runs, because they become smudged and blurred with handling.

To *preserve* your original drawings, use the PHOTACT process. After you make the negative, your original drawing may be filed away as a record—preserved from damage. The PHOTACTS made from this negative are used to produce all your blueprints or black line prints.

PHOTACT also *restores.* Old, smudged, overhandled original drawings come out sharper and cleaner in the PHOTACT reproduction.

PHOTACT *duplicates* your original drawing as many times as you need. From your negative you make as many PHOTACTS as required for use with government contracts, for sub-contractors or any of the other purposes for which duplicates are necessary.

PHOTACTS, even when made from pencil drawings are equal to fine ink tracings. Therefore, blueprints and black line prints made from them are always sharp and clear.

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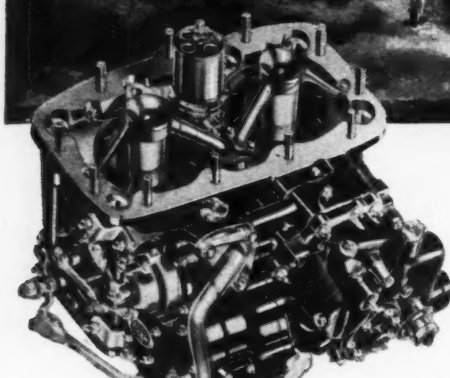


"Stromberg" Carburetion

HELPS MAKE BOMBERS *GOOD FIGHTERS*, TOO!

America's heavy bombers are constantly proving themselves *tough scrappers* as well as deadly destroyers of bridges, war plants, oil dumps and other objectives.

Flying far beyond the range of their own escorts they can blast their way through swarms of enemy fighter planes, not only because of well-trained crews and adequate armament but also because "*Stromberg*" *carburetion* makes them highly maneuverable. In the Flying Fortress, the Liberator and other large bombers, "BENDIX-STROMBERG" Injection Carburetors assure correct fuel mixtures under *all* conditions of flight, including the diving, climbing, twisting and turning which are a part of every air battle.

The life-saving *constant* power, made certain by "BENDIX-STROMBERG" Carburetion, means also reduced icing hazards, more economical fuel consumption and more accurate calculation of a bomber's safe raiding range.

"Stromberg"

INJECTION CARBURETOR

The "STROMBERG" Aircraft Carburetor is an important member of "The Invisible Crew"... precision instruments, and controls, which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

BENDIX PRODUCTS DIVISION
of Bendix Aviation Corporation
South Bend, Indiana

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

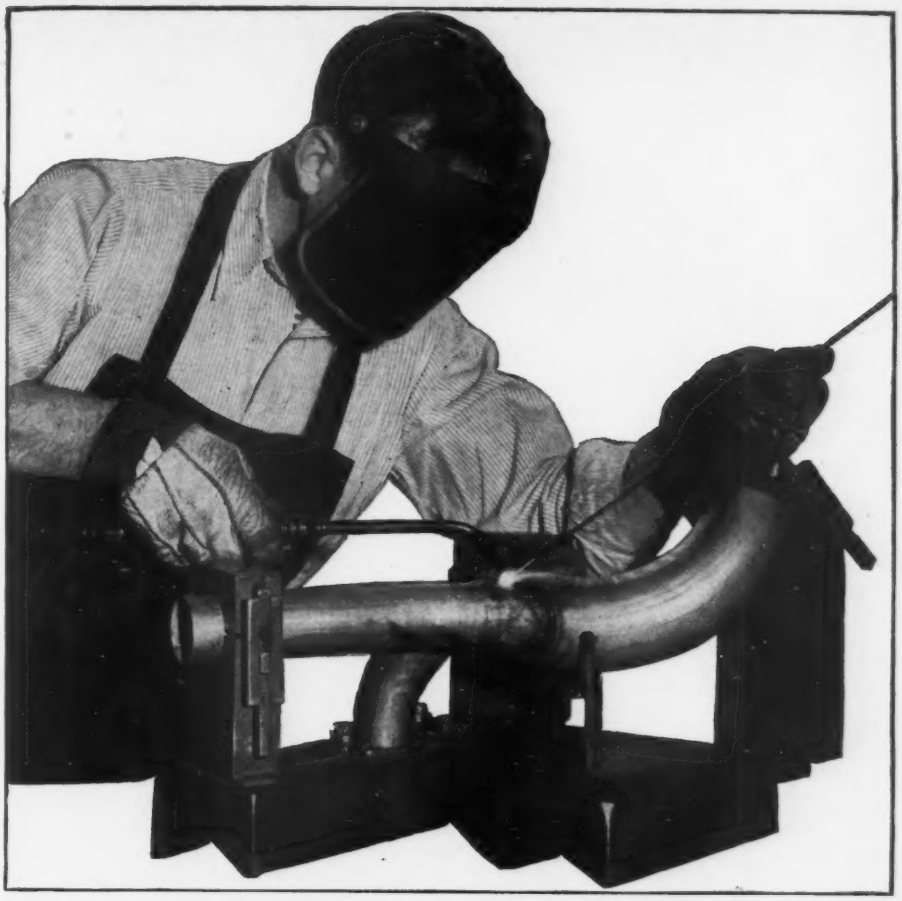
the manufacture of the part, he enters the contractor's plant with the knowledge that he must coach him and his workers on the technique which they must acquire. A man who has worked for Consolidated on the particular job can help a subcontractor over pitfalls which cannot be shown on blue-prints and drawings.

After the subcontractor has been operating some time, this man is usually withdrawn. However, Consolidated stands by with field men to step in and correct production problems, for frequently subcontractors call in to say, "We know something is wrong out here, but we don't know what it is."

So the company sends a man who can look at the problem with new eyes—a fresh viewpoint. Usually the trouble can be licked in short order. Recently, one subcontractor showed up with a problem, and our check revealed that under his man-hour schedule he could not hope to build the number of units he had promised. We estimated, through a study of log-log charts showing man-hour studies and expected efficiency increase, together with available man-hours per work week, that he would produce only 40 or 50 units in the given period, and he actually produced 40.

While Consolidated is subcontracting more subassemblies than many other aircraft manufacturers, it has one of the largest and finest machine shops on the West Coast, so that little machine jobbing is farmed out. The geographic location and lack of machine jobbing facilities in this area have made continual expansion mandatory. While such facilities are available in the larger cities, competition from aircraft manufacturing companies in those centers proved a problem. They were able to exert greater pressure and obtain priority on the use of the facilities because of the fact that they were nearby. Although other aircraft prime manufacturers place substantial machine jobbing outside, Consolidated policy has been to accelerate its program by subcontracting major subassemblies of sheet metal which include parts of a machined nature, such as the items mentioned in the beginning of this article.

As can readily be seen, the "feeder-shop" system of utilizing outlying "satellite" communities to establish small shops operated by Consolidated and under company foreman has little to do with the actual business of subcontracting. It is the general belief that this feeder-shop plan will meet with considerable success, but that it has its limitations. Among these limitations is the fact that at present most jobs must be non-machine work, such as upholstering, electrical harness, tube bending, and relatively non-mechanized work.



SKILL COUNTS IN AIRCRAFT WELDING!

Organized more than five years ago for the sole purpose of serving the Army Air Forces, as well as the more prominent airplane manufacturing companies, this company is in an unique position since its entire personnel and experience have been used in the development of men and facilities for the production of airplane parts and assemblies. Welding technique, particularly, has been developed to a high degree, and through recent increases in facilities and personnel, *we are now ready to offer the welding experience of this company to a limited number of new customers.*

KAY PRODUCTS COMPANY

4825 CABOT STREET, DETROIT, MICHIGAN

DIVISION OF TYLER FIXTURE CORP., NILES, MICH.

AIRCRAFT WELDING

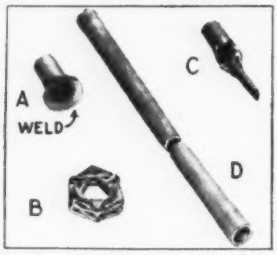
If you want STRENGTH in Tubular Parts . . .

The operations performed on these sections of Welded Stainless Tubing demonstrate its ability to withstand severe bending and forming.

Welded Stainless Tubing is often used to support loads once carried by carbon steel, or solid bars. Its strength/weight ratio allows the use of lighter gauges, without sacrificing strength. That means easier fabricating, less weight and considerable materials savings.

In addition to the tests described below, exacting inspection standards and hydrostatic pressure tests safeguard the quality of Carpenter Welded Stainless Tubing.

Tests Made To Determine Strength of Carpenter Welded Stainless Tubing
(Test pieces taken from regular production runs)



A. FLARE TEST—*Note that when the break finally occurred, it was AWAY FROM the weld.*

B. CRUSH TEST—*The even "fold" here shows the ability of the weld to withstand severe treatment.*

C. BENDING TEST—*This reverse bend along the weld again indicates the strength of the weld.*

D. TENSILE TEST —*Note the uniformity of elongation and the clean break on this typical specimen.*

Carpenter Welded Stainless Tubing *resists corrosion, heat and wear; meets U. S. Government specifications; is furnished in various types to meet specific conditions in service.*

Carpenter's "Quick Facts" bulletins are used in many plants to help speed the production of products and parts made from Welded Stainless Tubing. They make it easier to apply the advantages of this type of tubing to YOUR products. A note on your company letterhead will start your series of "Quick Facts" bulletins on the way.

THE CARPENTER STEEL COMPANY
Welded Alloy Tube Division, Kenilworth, N. J.

Carpenter
WELDED
STAINLESS TUBING

This is because machinery is not available and special types of buildings cannot be found. At present, three shops are being operated in communities between San Diego and Los Angeles, and a survey is being made which may incorporate company-operated shops in 12 to 14 more areas.

It is felt to be inadvisable to come within 50 mi. of the main plant with a company feeder-shop due to the fact that manpower in these districts has been more or less exhausted. Present indications lead us to believe that the outside limits of the area which we can use for these feeder-shops is about 150 mi. Beyond this radius, transportation charges between the home plant and feeder-shop become so high that little is gained by establishment of the shop.

Consolidated at present is employing only 204 persons in the feeder-shops now established. However, the company has found that it is getting a high type of worker in these outlying communities. There are many people who wish to do war work but who are unable to go long distances to places of employment. By bringing production to these people, we are making it possible for them to participate in the war effort.

In summary, it may be said that the problem of subcontracting is to find the right subcontractor, then to work with him in every way possible to establish him as a successful contributing factor to production. It is going to be more and more necessary to displace men, materials, and tools to make room for expansion and, with the local labor market at the point of exhaustion and available plant area taxed to capacity, subcontracting under supervision is only apparent answer.

Review of Patents

(*Continued from page* 192)

Wing Structure for Aircraft relates to structure having an additional wing which, under normal flying conditions, is embedded in the stationary wing and can be protracted for take-offs or landings. Additional wing is movable in direction of flight and is connected with stationary wing and fuselage.—2,306,015, C. Dornier, vested in Alien Property Custodian.

Regulating Device for Engines with two superchargers is intended for planes in which one supercharger is turbine-exhaust driven, the other mechanically from the engine crankshaft. Object of invention is to provide automatic regulation of the two ranges of charging pressure—that obtained mechanically or that from both superchargers operating together.—2,305,-810, A. Muller, vested in Alien Property Custodian.

Gas Turbine Plant for Propulsion of aircraft and watercraft is system including variable pitch propeller and means for regulating its angle of incidence so as to establish and maintain at all times a desired ratio between propeller moment and driving moment. Speed of the plant is controlled by variation of propeller moment and thus provides operation of plant at maximum efficiency throughout wide range of speeds.—2,306,953. I. Jung, assignor to Brown, Boveri & Cie.

Vibration Suppressor. Engine crankshaft is provided with dynamic vibration balancer which suppresses torsional vibration frequencies within one and one-half and three and one-half cycles per crankshaft revolution. Rotating body is provided with a dynamically acting mass.—2,306,956, A. H. King, assignor to United Aircraft Corp.

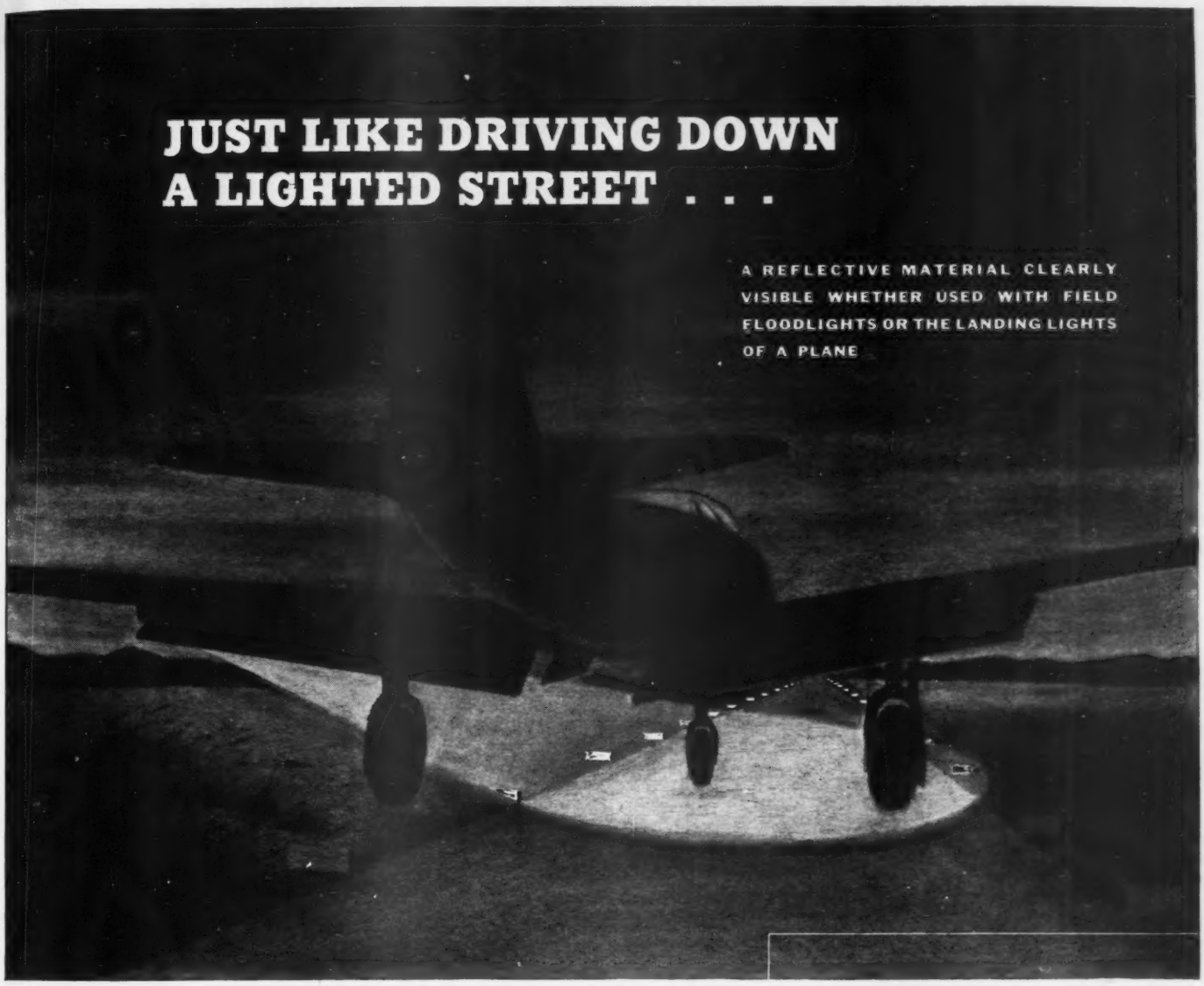
Aircraft Cabin Pressure Controller. Valve controls exhaust of air from cabin and fresh air under pressure is continually forced in. Objects of invention are: 1. To provide simplified control for establishing a pressure differential between internal cabin pressure and external atmospheric pressure, 2. To maintain a constant supercharged pressure, 3. To provide means of changing pressure differential at will, and 4. To afford regulation of rate of change of cabin pressure entailed in variation of supercharged differential.—2,307,199, J. B. Cooper, assignor to Boeing Aircraft Co.

Means for Obtaining Relative Movement of aircraft parts. A small reversible electric motor forms a constituent of strut extending between two points of suspension. Rotation of motor shaft is converted directly or indirectly into a longitudinal movement of strut rod. Invention can take several forms of construction. One includes provision of a hollow space in motor part of strut in which strut rod moves longitudinally in direction of an axis coinciding with motor axis.—2,307,-317, C. Konig, vested in the Alien Property Custodian.

Automatic Control Apparatus involves an azimuth gyroscope or other turn indicator controlling rudder of aircraft, together with means for changing course. Improvements are stated to enable banked turns to be performed in a simple manner, and the rudder is automatically actuated to suppress side-slips.—2,307,941, F. W. Meredith, assignor to S. Smith and Sons (Motor Accessories, Ltd.).

Aeronautical Oxygen Regulator comprises a multi-stage gas pressure reducing regulator of diaphragm type with an aneroid controlling unit in last stage as well as push-button operated device for by-passing restricted flow of oxygen directly to breathing chamber. It has safety features in case of failure of regular delivery of oxygen to aviator's helmet.—2,308,124, L. W. Stettner, assignor, Victor Equip. Co.

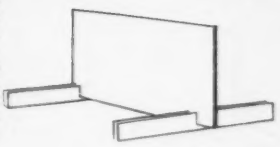
JUST LIKE DRIVING DOWN A LIGHTED STREET . . .



A REFLECTIVE MATERIAL CLEARLY VISIBLE WHETHER USED WITH FIELD FLOODLIGHTS OR THE LANDING LIGHTS OF A PLANE

SCOTCHLITE MARKED RUNWAYS AID SAFE LANDINGS . . . .

The illustrated marker shows the most popular of several constructions. Approximate size two feet wide by one foot high. This measurement can be varied to meet your needs.



YOU can mark runways or taxiways with "SCOTCHLITE" in a few minutes' time so as to be efficiently used with floodlights or landing lights on a plane. "SCOTCHLITE" is a reflective sheeting applied to markers which can be quickly made to meet your requirements in size or shape.

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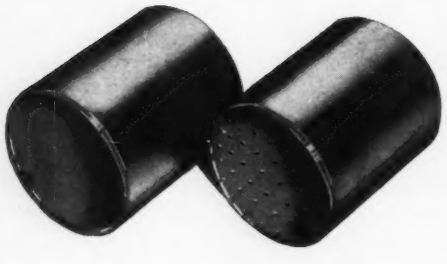

The business of dropping a package of "eggs" on Tojo is easier and more efficient because of sleeve type bearings. The interesting feature of this application is that it employs a bearing material as new as the war.

Johnson Pre-Cast Bearing BRONZE-ON-STEEL was developed to meet peacetime applications but, like many another product, it was easily converted to armament needs. When peace returns, manufacturers will find that Johnson BRONZE-ON-STEEL . . . combining the bearing qualities of BRONZE with the strength of STEEL . . . will give them greater bearing performance in their product. It will be available as finished bearings or in strip form for stampings. It is an ideal metal for washers or other flat pieces. Complete information can be had by writing the Johnson Bronze Company, 620 South Mill Street, New Castle, Penna.

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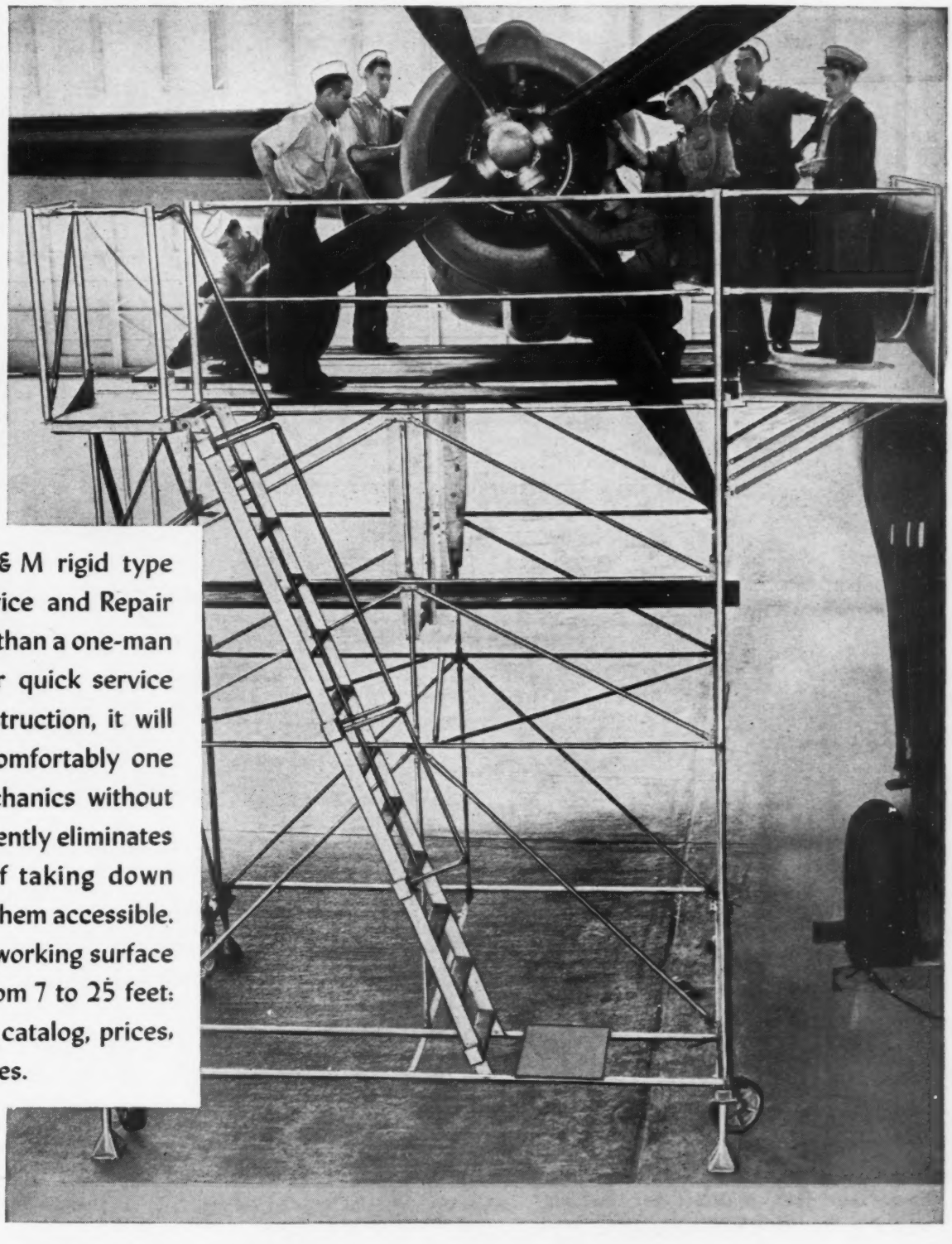

The W & M rigid type knockdown Service and Repair Platform is more than a one-man stand. Ideal for quick service jobs and field instruction, it will accommodate comfortably one or a dozen mechanics without crowding. Frequently eliminates the necessity of taking down motors to make them accessible. Provides a rigid working surface for any height from 7 to 25 feet. Write today for catalog, prices, and delivery dates.

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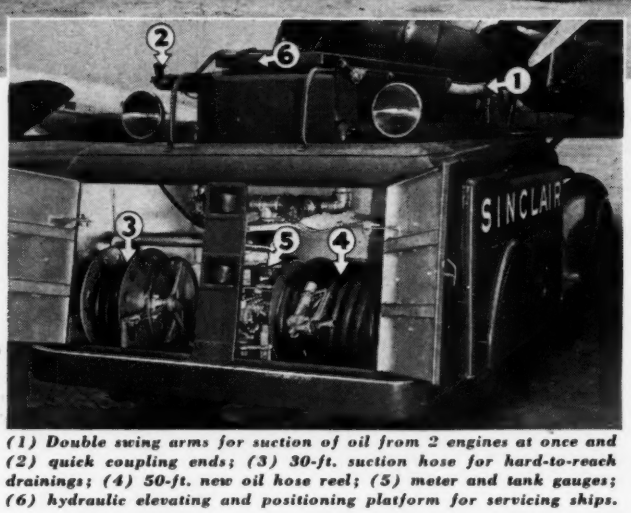

(1) Double swing arms for suction of oil from 2 engines at once and (2) quick coupling ends; (3) 30-ft. suction hose for hard-to-reach drainings; (4) 50-ft. new oil hose reel; (5) meter and tank gauges; (6) hydraulic elevating and positioning platform for servicing ships.

Fast ground servicing despite manpower shortage is a wartime problem of air transportation.

The new Sinclair Oil-Jeep helps American Airlines in their man-hour and ground-time saving program. An aerial, hydraulic positioning platform permits speedy servicing of the largest airplane without ladders or "monkey-climbing" over de-icers and wings.

The Oil-Jeep handles all services—both new and used oil. Two, or even three engines may be drained simultaneously and refilled without moving the Oil-Jeep.

American Airlines now has new service honors—the 1942 *Aviation* Award for "outstanding maintenance performance." Every mile of flying by its great Flagship fleet is lubricated by Sinclair Pennsylvania Motor Oil.

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Aircraft Service Organization—The Gateway to Sound Operation

(*Continued from page* 213)

And he may ask the squadron commander to stand out on the field and flag in a few landings, as on shipboard, slowing down landing speeds, regulating heights, until the pilots get a uniform approach in keeping with the requirements.

A great number of engine changes may be recorded for one location. What is the reason—a failure of parts, or perhaps unanticipated climatic conditions, or is it merely due to time run up? All such items, as shown on reports and analysed in summaries, pave the way to timely remedy at the right spot, putting planes back in the air as quickly as possible and forestalling unnecessary breakdowns. The only possible way to do this is by complete and continual records which point to the causes of each problem.

On the basis of all this accumulated experience is compiled the very inclusive service procedure manual for *Aircobras*. This volume institutes standard maintenance procedure all over the world, and with the complexity of the modern combat plane, it is no small task to establish a practical and successful working routine.

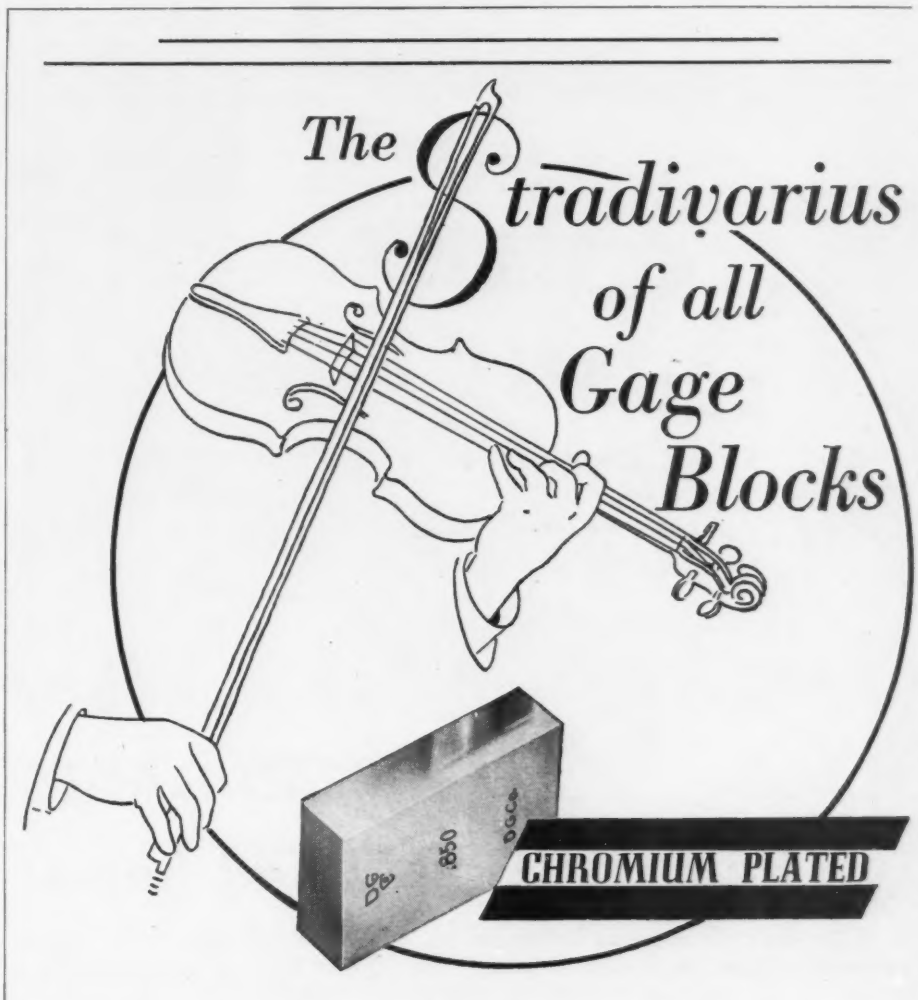
One thing often lost sight of is the delicate matter of weight distribution. A fighter is designed with a certain balance in mind, and this and no other will do. Individuals may remove this or that item of equipment, or thoughtlessly add a weight factor. Subsequent flight peculiarities and perhaps accidents, which may discredit the ship, are due to this carelessness. Here again, the presence of a specifically trained service representative can put the trouble quickly to rights and avert future mishaps.

This accumulation of sorted and analysed information represents the sum total of the design's performance and characteristics in the field and as such is an indispensable partner in future design. Extremists who want to dictate to the engineers from a maintenance standpoint wave a red flag before a bull, but still it must be said that any design drawn up without a partnership in this direction is in grave danger of repeating mistakes which could be avoided. By putting intelligently sorted experience at the disposal of design engineers, progress can be straight ahead and not in circles.

In connection with the wartime problem of parts shipment, the Service Division has answers to this important and difficult question. We had occasion to learn from British experience in this matter. Their parts requisitions called for a seemingly large number of individual parts—in the neighborhood of 3,000—in contrast to our much smaller lists consisting of larger assemblies. In actual practice, as reflected through service information as well as through British experience, shipment of individual parts as predicated on analyses of failures is the economical way to distribute materials where they will do most good.

Landing gear failure never involves the whole assembly—it's the fittings, or spindles, or certain other parts. To ship whole assembly units is wasteful of material, uses up invaluable transport facility, and accomplishes nothing for the replacement depot, when the replacement required is a fractional part of the whole. The essentially extravagant character of American philosophy is manifested here, whereas the necessity confronting the British economy has stripped their system to bare essentials.

This problem of parts shipment, however, is perhaps the most serious obstacle to getting efficient use from our aircraft shipped abroad, and the answers lie in just such a system as has



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proven so effective in servicing *Airacobras.* The foreign service kits which have been sent out with these planes have saved many an otherwise prolonged delay.

In these days of critical manpower supply, the Service Training system in operation at Bell is of particular importance. This unit is in charge of Alvin T. Lines, who in 1928 taught the first state subsidized class in aeronautics in Buffalo. In the last year, the Service Training School has turned out 140 trained representatives into the field, of whom very few came from inside our existing organization. Now all applicants must be taken from outside because of production needs.

At the very beginning in the selection of applicants, great pains are taken to find out the aptitudes, experience, and even hobbies which relate to the requirements. There are no trained men available now, so that of those interviewed, none may have had job experience related to aircraft. But a printer may have had enough mechanical association to make the start easier. If a man has owned a motor boat, or had a hobby of a mechanical nature, he may also show promise. All these things are dug out and used to their fullest extent in furthering the difficult job of selection.

The first week of training, spent in the laboratory, is devoted to odd jobs of kinds to see how the men work with basic tools. From the beginning of training, each man's progress and ability is recorded so that he can be continuously evaluated and his instruction balanced.

A six weeks period following this is spent in intensive study on six major divisions of the aircraft—structure, power plant, armament, electrical system, landing gear, and propeller. There is a special classroom for each of these subjects, with very complete instruction equipment, exploded-view charts, working mock-ups, cut away models, and tools. The distance covered in this session is based on considerable home study to supplement the class work, otherwise it could not be accomplished.

After this, the men are put through a brief period of instructing to get the feel of teaching others. This is followed by a period of work at the modification center, which, as shown in the organization chart, is within the Service Division.

There follows a four-weeks period on operations where a man spends the first week as a mechanic, the second as lead man, the third and fourth as a foreman. Passing grades in this session end a man's student classification, and he becomes a Junior Representative. In this capacity he is sent into the field for 60 days. Reports on his performance and knowledge indicate the next steps to be taken in his training.

When he returns, we call him in for an interview and ask him what he did not know while out in the field. He may be able to tell us and he may not, but the records kept of his activity have already determined his next course of study, which consists of three weeks advanced work on his specific weak spots.

Upon completion of this, he becomes a Representative and is again sent out, this time for eight months. In the middle of this period he advances in pay rate, and it might be said here that every step is accompanied by a proportional pay rise.

After this period of active work, a man returns once more for a finishing course in design theory which gives him an understanding of the engineering side of the subject. A graduate of this section is a Senior Representative. Only men of this grade can be in charge of a base operating with more than one service man.

The domestic field is divided into five districts, each in charge of a supervisor and two assistants. One of these assistants works in the district, the other on operations at the home office as repre-

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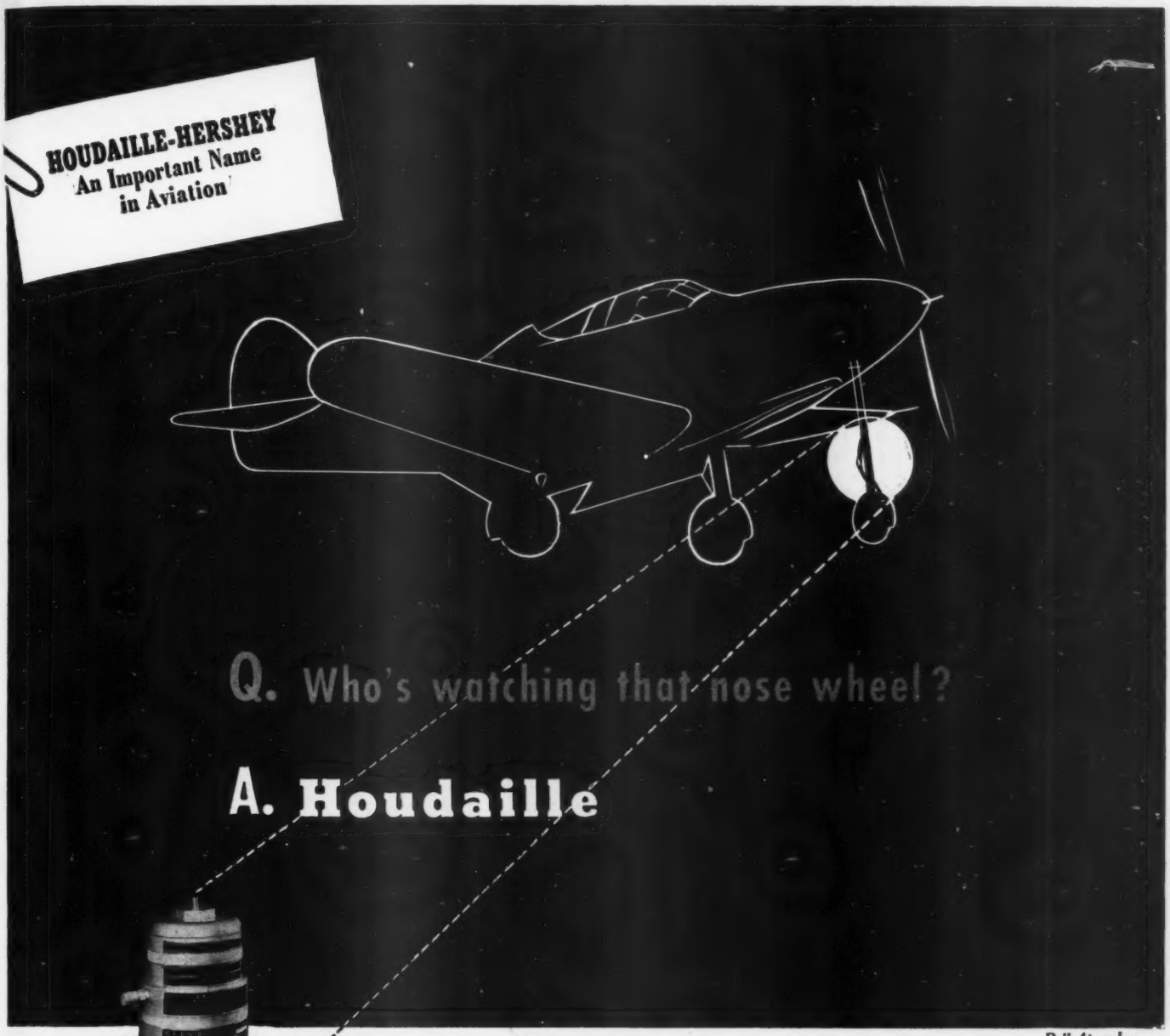

Bell Airacobra

Remember in the early days of balloon tires when your car would develop a terrifying shimmy and nearly shake itself out of control? Imagine, then, what would happen if the same trouble overtook an airplane in taking off or landing at 90 miles an hour.

Because a shimmying nose wheel on a tricycle landing gear easily could cause disaster, some means of control is vital. For this purpose we build hydraulic dampers which offer little hindrance to steering and yet which impose ever-increasing resistance as shimmy forces mount. Today they are functioning successfully on many types of planes—from the highest-speed fighters to the heaviest bombers.

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Use Klixon Circuit Protectors

It's a real break for a pilot to have Klixon Circuit Breakers in his plane. It means less trouble, less fussing around, plus sound, foolproof, circuit protection.

To begin with, a harmless transient short will not cause a Klixon Circuit to trip out. Needless breaks are eliminated. But if the short is sustained and dangerous — bing — the Klixon Breaker opens *with snap action.* And, to make it completely simple for the pilot, once the overload conditions are corrected, he merely pushes a button or flips a switch and the circuit is reestablished.

Send for complete bulletins on these proven circuit breakers and protectors—now.

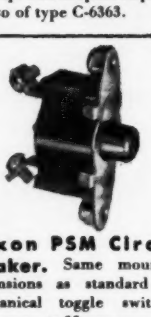
SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

Klixon PM-1" Circuit Protector. Ratings from 5-40 amps in steps of 5. Weight, 1½ ounces.

Klixon PLM-1½" Circuit Protector. Ratings from 25 amps through 150 amps. Compact and light in weight.

Klixon Type D-6364 Switch Type Circuit Breaker. Ratings from 35 amps up. Fits in space required for two of type C-6363.

Klixon Type 6363 Switch Type Circuit Breaker. Ratings from 5-30 amps in steps of 5. Small and light in weight.



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sentative of his region. These men work in three-month periods, then change in rotation with the other assistants.

Purpose of having an assistant from each district on home operations is to let each have an insight into the whys and why nots of supply. Every assistant supervisor is in complete charge of district affairs at the home office, sitting in on all conferences with other districts and with military officials. In this way, there is no one-sided complaint from the district or the assistants, because they all have a balanced control and an understanding of the country-wide system.

Service men for foreign duty are selected by the Supervisor of each district from his best qualified men, for in this service they are completely on their own and have considerable responsibility with the military units (see p. 60 Dec. AVIATION). Selectees are held in a central pool on 48-hr. travel notice. Alternate choices are held in reserve, and here competition is promoted among the men seeking to qualify for the next selection.

Prominent in the Service Division is the Technical Maintenance Department, which coordinates with Engineering. As an exponent of the growing design philosophy which recognizes the importance of service problems, this unit links together the vital knowledge and experience of each department. From the time the first two pieces of metal come together, the Technical Maintenance department follows the plane design and construction. With this thorough basic understanding of the plane, from start to finish, the Service Division can compile its manuals and train its men. Later work of Technical Maintenance on failures and accidents in the field and analyses of causes from a design and engineering view, is of great importance to the Engineering Department, both for modification of designs in production and for avoiding repetition of previous pitfalls in new design.

In addition to company training, Camp Bell puts at Army disposal the best teaching facilities, with courses worked out for many purposes. The standard course is 27 days, covering in concentrated form the material given in the six-weeks company course.

In the strategic world picture, reports from abroad indicate a great need for a coordinated system of maintenance supply. Any large business today has a highly organized system of report analysis and control which, although complicated, pays dividends as an index of condition and trend.

The system set up at Bell Aircraft has proven what can be done in this direction, and it is my great hope, to further this work.

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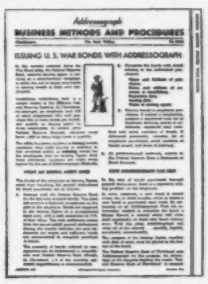
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Design Considerations for Plywood Structures

(*Continued from page* 167)

of the required bending strength and rigidity of the skin about its span axis. Evaluation of this involves a least-work computation and depends upon the distribution of flange material about the shell.

Evaluation of the shear forces in the skin is based on NACA Tech. Note No. 562, which defines the shear stress in the nose skin of a Dee-spar wing as—

(1) $f_s\ s_n = f_s\ s_w$ for a simple distribution of shearing stress.

The case at hand is somewhat complicated by varying skin thicknesses but is susceptible to the following treatment. Considering a 1-in. spanwise section of wing, equation (1) may be rewritten as—

$$(1A)\quad \int_A^B f_s \Delta s_n = \int_A^B f_s \Delta s_w \qquad \text{(See Fig. 6)}$$

Considering a 1-lb. vertical shear load acting on the section, the shear stress f_s will be obtained by assuming the rear web cut at "A" and the shear force replaced by a load "X" or—

$$(2)\quad f_s = \left[\left(\frac{\Sigma\, A z_o}{I}\right)\left(\frac{1}{t}\right) - \left(\frac{X}{t}\right)\right] =$$

shear stress at any point on shell where:

A = Flange material increments

z_o = distance, neutral axis of wing section to controid of A

I = moment of inertia of entire cross section about chord axis

t = Skin thickness–subscript W for vertical web and n for skin

X = Shear load per inch on rear web

f_s = Shear stress in psi.

Δs = increment of shell length

Substituting (2) in (1A)—

$$(3)\quad \int_A^B \left[\left(\frac{\Sigma A\, z_o}{I}\right)\left(\frac{1}{t_n}\right) - \left(\frac{X}{t_n}\right)\right] s_n = \int_A^B \frac{X}{t_w} \Delta s_w$$

Note: The above is based on the assumption that the shear rigidity is the same for all portions of the shell and that the rear web is incapable of resisting bending forces.

Solving (3) for "X"—

$$(4)\quad \text{"}X\text{"} = \frac{\displaystyle\int_A^B \frac{\Sigma A\, z_o}{I}\,\frac{\Delta s_n}{t}}{\displaystyle\int_A^B \frac{s_n}{t_n} + \int_A^B \frac{s_w}{t_w}}$$

Evaluation of (4) is slightly laborious for a complicated section but nevertheless feasible. The determination of "X" permits computation of the shear stress in all portions of the shell by means of (2). The centroid of resistance to shear may also then be determined by taking moments of the forces "$f_s\ t\ s_n$" about any convenient point. A similar procedure about the vertical axis provides the value of the shear stresses due to chordwise forces. Shear due to torsion is obtained from—

$$f_s = \frac{T}{2\,A\,t}$$

. . .and the algebraic summation provides full information as to the actual shear stresses at any point.

The above method was applied to a test wing panel of constant chord and values of the centroid of shear resistance obtained experimentally. Comparison between test and computed values were 24.1 percent from computation versus 24.9 percent from the experimental determination. This agreement is felt to be sufficiently close in view of the fact that the arms to the shear forces were scaled from a quarter-size layout.

Shell Stiffness

Computation of the bending moments in the shell is feasible using the air load distribution for a given angle of

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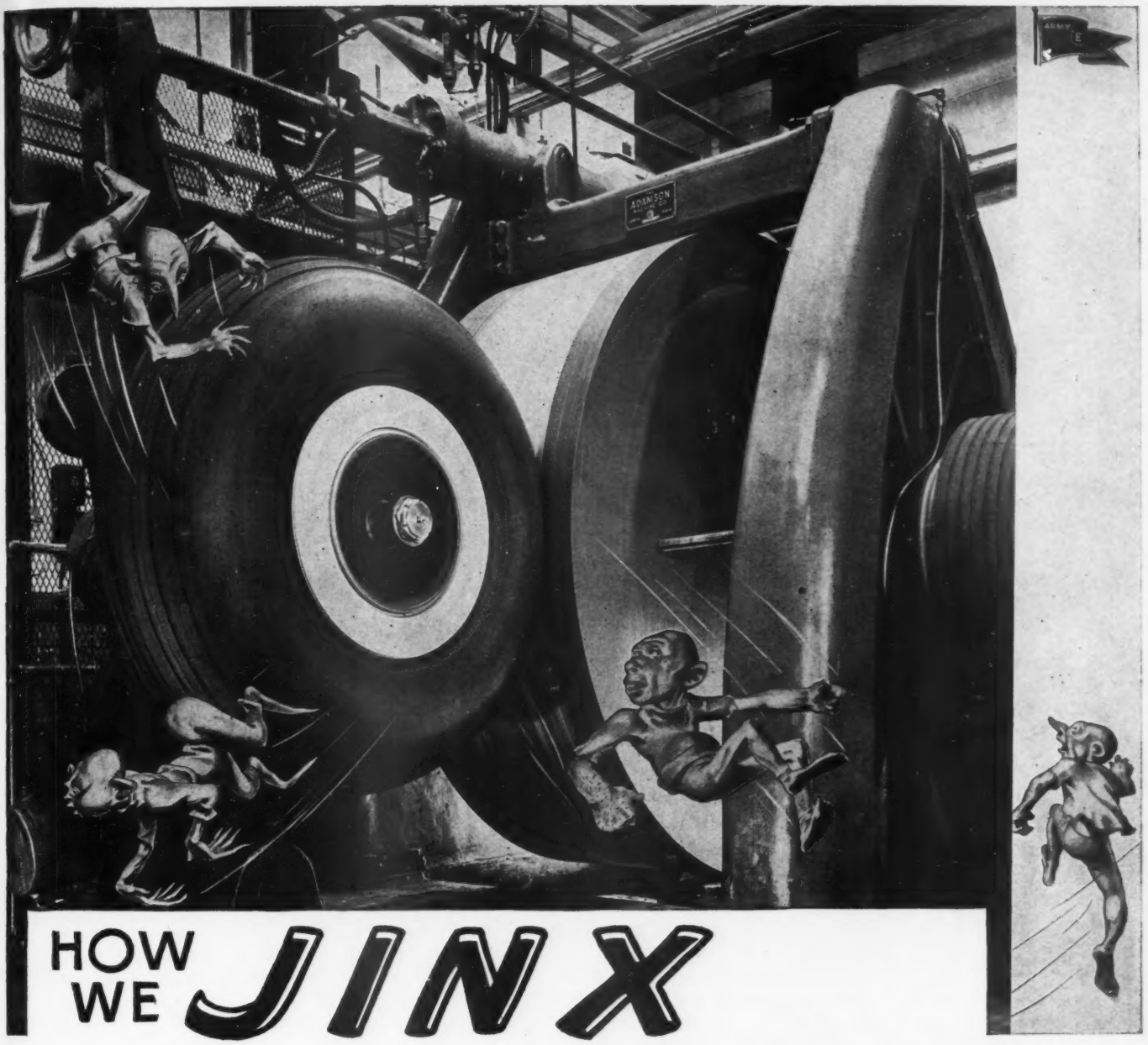

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"Aircraft landing gear is no place for gremlins," is the way we figure it.

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With our famed Hayes Expander Tube Brake, as with all our wheels and brakes—our job is supplying aircraft designers and builders—and our army and navy air forces—with combat-proved equipment for **accurate ground control.**

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#2 man in a single-place pursuit

Johnny never will get a medal for shooting down Messerschmitts or Zeros. He doesn't do any shooting. He's just one of the ground crew. But he plays an important part in each fight.

#2 men don't get medals. But they're doing a real job.

* * * *

Thousands of American pilots put their full trust in their ground crews every time they take off. But then a pilot must trust so many things . . . from their own ability to the smallest part in the engine.

We, here at Resistoflex, like to feel that thousands of these American flyers are putting their trust in us, too. In our ability to produce flexible instrument and hydraulic hose assemblies. We know how carefully these lines are made and inspected. We know how they stand up in our "torture machines." Now, we are beginning to hear how hundreds of thousands of them are withstanding the abuse of actual combat service.

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attack and resisted by forces Δf_s proportional to those obtained from equation (2). Introduction of vertical spacers requires, for any degree of accuracy, inclusion of the three additional redundancies introduced by each spreader. Computations involved by this extension have been sufficiently appalling to encourage their omission on wings constructed to date, although the value of such investigation is undeniable.

Following well recognized design practice where insufficient information is available, a careful estimate was made as to the size of skin stiffeners necessary. First estimates proved to be conservative in that the stiffeners did not fail during load tests and subsequent work was then based on the first guess with the depth varied somewhat in proportion to the square root of the load. Original structures of this type were arranged with a diamond pattern of reinforcement in the belief that torsion and chord shear rigidity would be enhanced by this arrangement.

To exemplify, Fig. 6 depicts a typical stabilizer fabrication where the shell may be constructed on a single form and molded complete with stiffeners and half the leading edge. Two shells from the same form, together with the rear spar, comprise the finished structure.

Fig. 7 is an example of early wing construction. Here, the unit is molded from the forward flange to the flap/aileron cut-off, with the leading edge and rear web cold-glued into place as final assembly operations. And in Fig. 8, showing intermediate construction, the method is similar to that in Fig. 7, except that the flanges are wide and molded to contour.

Fig. 9 is a construction where the outer shell, molded on an "inside" form, is completed in one operation. Here, the tube spacer is replaced by a discontinuance plywood spreader, and the rear web is glued in as a final operation.

Fig. 10 shows an aileron skeleton for fabric-covered TE. This aileron is made with the web replaced by spacers. The interior, with the exception of the horn box, is completely open for inspection and repair.

Figs. 6 through 10 indicate the various stages of development of this arrangement. The first wing sections were constructed with diagonal sub-ribs of $\frac{1}{4}$-in.x$\frac{3}{4}$-in. spruce, with post spacers at each intersection. Observations during tests indicated the necessity of using spanwise flange material which was incorporated after the fashion of Fig. 7. In the interests of weight economy the solid leading edge used in the stabilizer was replaced by a molded leading edge in the wings, which was cold-glued in place as a closing piece. In Fig. 9 the tubular spacers have been replaced by a plywood spreader with

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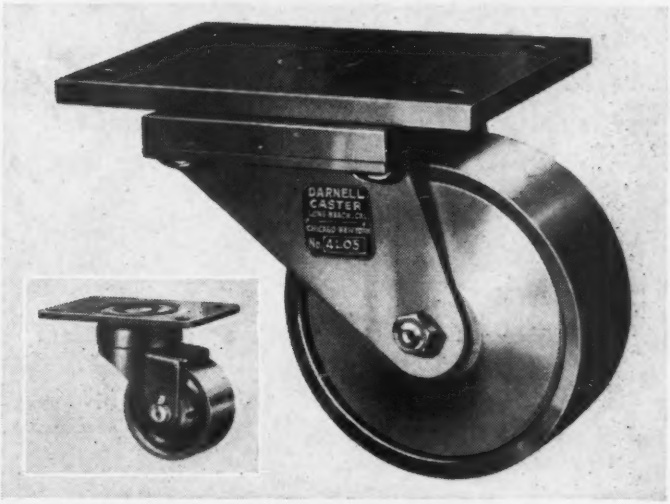

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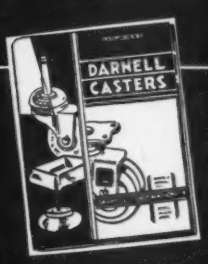

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the cold-joining of the leading edge eliminated by molding the shell integral.

In this instance the wing is "sprung" open to remove the form and is completed by the installation of the forward spacer, the rear channel, and two ribs. Diagonal ribbing has been replaced by a chord-wise rib without spacers or webs.

Examples of each of these wings have been put through tests, although not all have been carried to destruction. Enough data has been obtained to indicate the validity of basing a design on the following assumptions:

(a) Flange material designed to resist bending moments.

(b) Wing shell between flange material designed to carry shear stresses as determined from Equations (1) through (4). Note that the leading edge must be of sufficient rigidity and strength to prevent failure by buckling due to shear.

(c) Rib sizes may be estimated from the following:

Vlt. Loading Ave.	Rib Size	Panel Size	Skin t	Tube Spacers
70 psi	$\frac{1}{4}$"x$\frac{3}{4}$" diag.	12"x12"	3-1/45	Yes
325	$\frac{3}{8}$"x$\frac{3}{4}$"	8"x 8"	3-1/16	Yes
530	$\frac{1}{2}$"x$\frac{3}{4}$"	10"x 9"	3/16	No

Test Conclusions

A number of interesting points have been brought out in the course of tests. Of primary note was the practicability of obtaining a sufficiently substantial leading edge by designing a thickness to prevent buckling under shear loads. Another point of interest was the apparent substance of the diagonal rib grill without the plywood skin. This point was brought out by retest of one panel after removal of the plywood skin between stiffeners.

Preliminary tests had indicated the probability that the buckling of the sub-rib as a column would define the strength of the panel. During tests the wing with the cut out panel carried the predicted loads without failure of the sub-ribs.

The above paragraphs are offered in order to encourage efforts at structural innovation. Despite the fact that structures and structural engineering is an ancient and venerable occupation there is still a great unexplored region. The efforts in aircraft have been largely aimed at weight reduction and from this standpoint have been beautifully successful.

It should now be legitimate to turn at least a portion of the efforts of the aircraft structuralists towards exploration of simplified structures. Based on the achievements in the past ten years on increased weight efficiency, it is readily possible to achieve comparable improvements in labor efficiency and fabrication economy.

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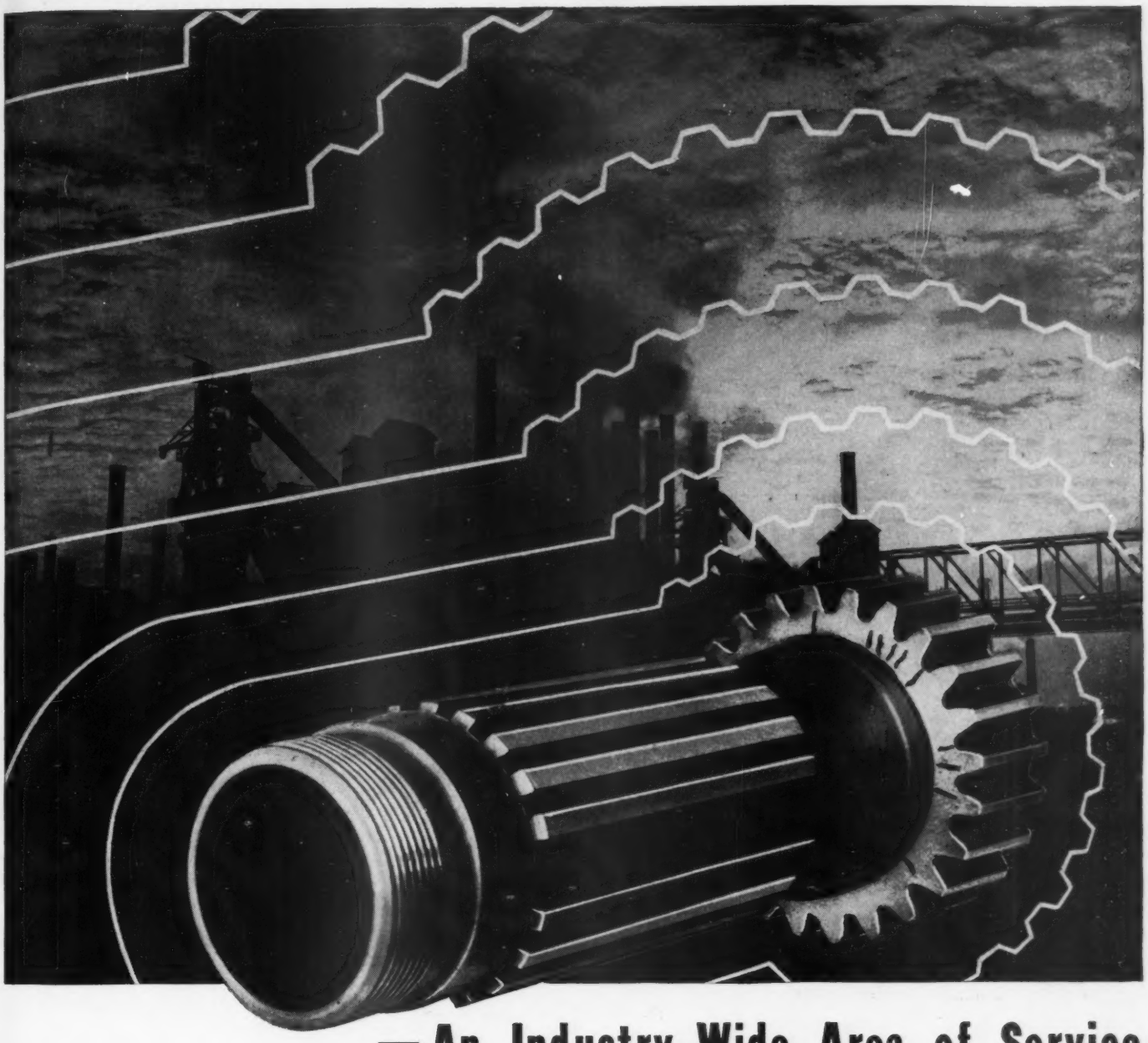

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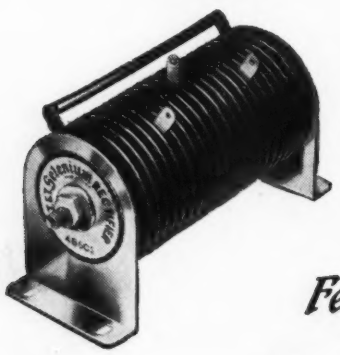

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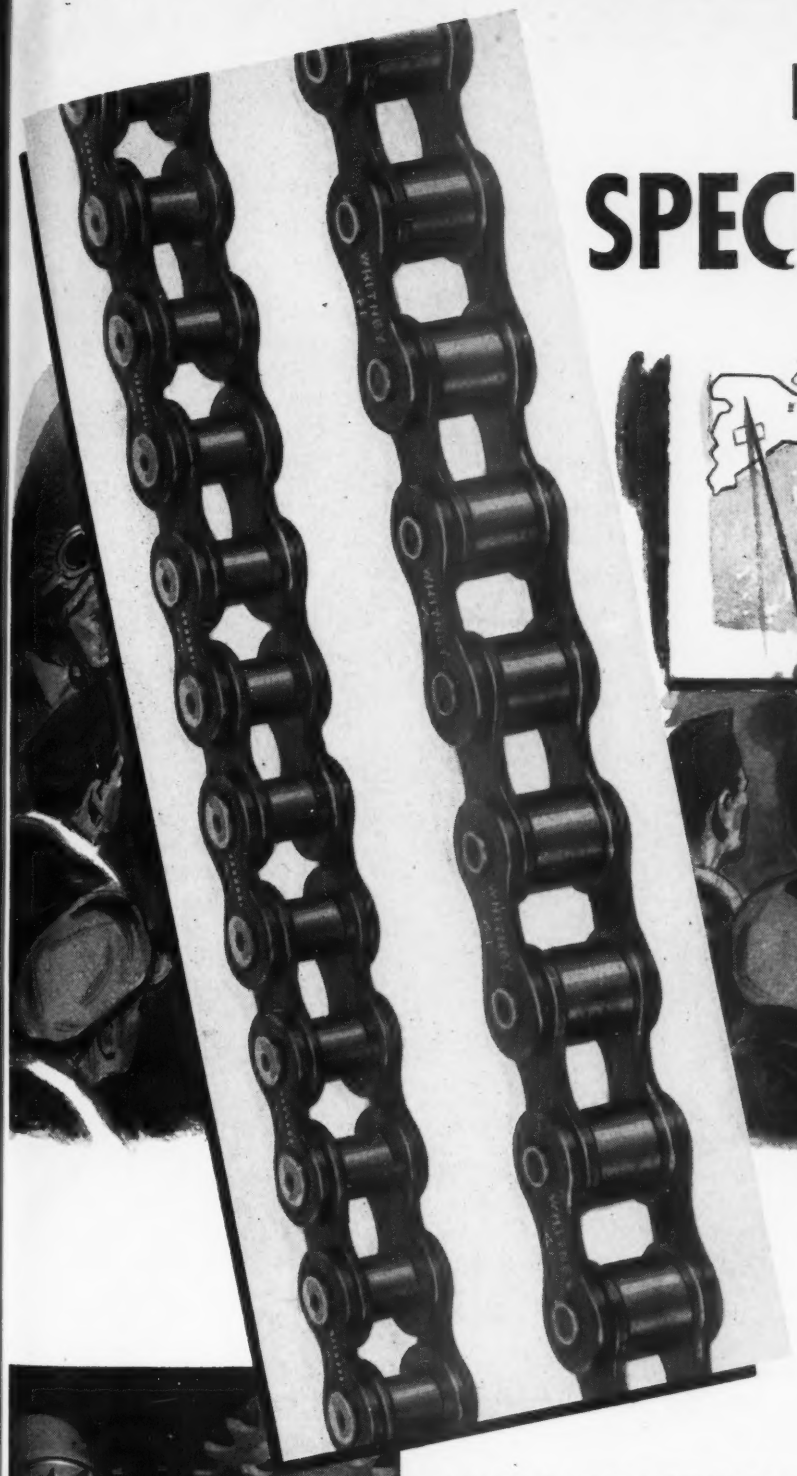

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Theory and Technique of Perspective Projection

(*Continued from page* 174)

quires the constructions of step 4 (of the procedure just outlined) for a few basic starting points, but it does not require the redrawing of the top view of the object. This slight advantage, however, is enlarged by the superposition.

If a worm's-eye view of the box is desired, then the *SP* is placed *below* the *GP* (upon which the box is assumed to rest) at a convenient and proper distance. Assuming again that the angle between the *PP* and *GP* is 45 deg., that the vertical edge *BF* is again the nearest to *PP*, the top view of the box will be drawn in the inclined position of Fig. 16, if the auxiliary view is given as shown, and if *PP* in the top and end views is an edge view, i.e., Type 1. Recall that in order to obtain a perspective with a small amount of distortion, the *SP* must be so placed that the *CV* will be somewhere in the center of the perspective. Following the rule that *HL* is the intersection of *HP* and *PP*, and that *HP* and *GP* are parallel, the *HL*, will fall *below GL*, as Fig. 16 indicated. Applying Principle 2, the *UVP* (up vanishing point) is where a sight line parallel to the line-set, of which line *BF* is part, pierces *PP*. Note that the *LVP* and *RVP* will be at the bottom of the figure, since *HL* is also there. As indicated in the outline of procedure immediately below, for obtaining the worm's-eye view of Fig. 16, a combination of Methods 1 and 2 is probably the best to use, in general, for three-point perspective, with Type 1 or 2. Referring to Fig. 16:

1. Locate *LVP*, *RVP*, and *UVP*.

2. Determine the perspective of *E* by Method 1. A horizontal projection line E'^{R} intersects a vertical projection line from E'^{T} at E^{P}.

3. Similarly locate H^{P}.

4. A line through E^{P} and H^{P} will locate *RVP* on *HL*. (In this way, *RVP* is found by Method 1.)

5. G^{P} is where the line H^{P} (*LVP*) intersects the vertical projection line from *M*.

6. F^{P} is the intersection of line G^{P} (*RVP*) and E^{P} (*LVP*).

7. Locate A^{P} in a manner similar to that used in 2 to locate E^{P}.

8. Determine perspectives of enough of the remaining points, as outlined in items 3 through 7 above, and draw in the complete perspective.

Here again, the author's superposition method may be used to great advantage in making perspective projections on a piece of tracing paper placed over the conventional engineering drawing which employs orthographic projection. This is illustrated by Fig. 17 and by the outline of procedure immediately below. Referring to Fig. 17, and temporarily ignoring the lower perspective. . .

1. *On the engineering drawing,* locate end views of *PP, SP, HL, GL,* and *UU,* also draw $(HL)^{P}$ perpendicular to the end view of *PP,* where a sight line, parallel, to $(GL)^{R}$, pierces *PP* (end view), and draw *UU* perpendicular to *PP,* end view, from where a sight line parallel to *BF* (end view) pierces *PP. On the tracing paper,* locate top views of *SP, HL, RVP, LVP,* and $(SP)Q$.

2. Determine points (in *PP,* top view) like P_A, P_B, etc., by the construction of step 4 in the consideration of Fig. 15a (beginning "Find A^{P} by method 1," etc.,). For example, $(A'')^{R}$ is determined from $(A')^{R}$, the piercing point of a sight line to *A*. And $(A'')^{R}$, laid off along $(SP)^{T}Q$, gives $(A'')^{T}$ for the horizontal projection line intersecting $(SP)^{T}A^{T}$ at P_A.

3. Move the tracing paper from the top view and match its *HL* with $(HL)^{P}$, being careful to locate *Q, LVP,* and *RVP* at such a position as to place the perspective in an unoccupied portion of the available working space.

4. Lines through P_A, P_B etc., perpendicular to $(HL)^{P}$, will intersect lines through piercing points in the right view—like $(A')^{R}$—at perspective points. For example, A^{P} is on a perpendicular to *PP* from $(A')^{R}$—where $(A')^{R}$ is the right view of where the sight line to A^{R} pierces *PP*—and also on a line *a-a*, which has been drawn through P_A after the pickup of the tracing paper.

5. Enough points are obtained by this superposition method and by using vanishing points wherever expedient to obtain the complete perspective.

It is to be noted in Fig. 17 that the end view of the engineering drawing has been raised above its normal position in order that the perspectives could be placed in a reasonable position, not too near the bottom of the available working space.

Be cautioned about placing the *RVP,* say, to the right of *LVP* after the pickup. This is how they appear from the *SP* in front of the *PP,* which is the plane of the paper at the perspectives. If these positions are reversed, the lower perspective of Fig. 17 will be obtained. This would be the perspective reflected by the *PP* to the *SP* and located an equal distance on the object side of *PP.*

Figs. 18 and 19 show the application of the principles, rules, and methods previously explained and deduced. The problem of obtaining a common perspective of the wing-tip float mechanism of one of Consolidated Aircraft's PBY flying boats, is not elementary;

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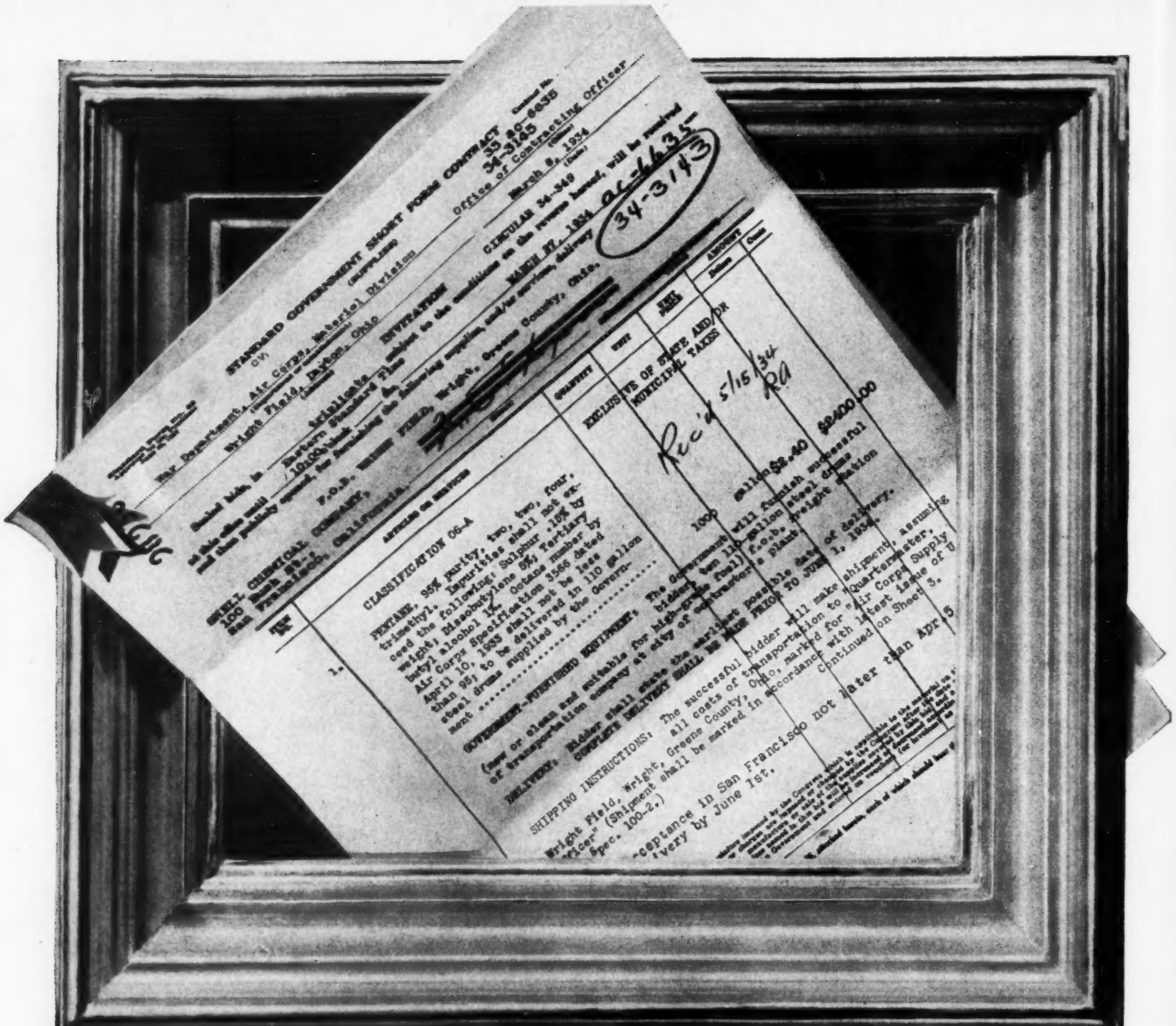
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it is typical of the advanced problem many professional engineers and draftsmen are more and more being compelled to solve in the production of a steady stream of needed commodities by workers, most of whom are unskilled or semi-skilled in the reading of the conventional, orthographic engineering drawing, but who can at a glance read a pictorial drawing of the type shown in the two figures.

The figures do not show the objects in complete detail, but they do reveal enough of the basic graphical solution to the problem for the engineer or draftsman of average ability and experience to proceed independently to the complete solution of the detailed object. The basic points, whose perspectives have been obtained in the figures, are those which the artist would first attempt to locate on his paper when using the inexact methods of "artists'" perspective. Definitely, he could not always obtain the correct points. The engineer or draftsman, with average ability and experience, but with no "artistic ability", can determine the *exact* locations of these basic points for the artist, who can then exercise his ability to sketch fair curves, detail the perspective, and properly render or shade the sketch or drawing.

Fig. 18 illustrates the use of Method 1, Type 2. As pointed out, no locations of *VP's* are required, but the end and top views must be redrawn if the *PP* in the end and top view is to appear as an edge when obtaining bird's-eye or worm's-eye views. The latter method, a combination of Methods 1 and 2 used in conjunction with the author's superposition method, is that of Fig. 19. Redrawing the top and end views of the object is not required there. Although the constructions and methods used in Figs. 17 and 19 are essentially alike, a brief explanation of Fig. 19 may be helpful. Therefore . . .

1. On engineering drawing, locate end views of *PP, SP, HL,* and *UU* and on tracing paper, locate top views of *SP, HL, RVP, LVP,* and *(SP)Q*.

2. Determine the points, like P_A, in the top view on the tracing paper.

3. Now superpose the top view, obtained in 2 above, on the perspective portion by matching $(HL)^T$ and $(HL)^P$, being careful to locate *Q* at such a position as to place the perspective to be drawn in an occupied portion of the available working space.

4. Lines through points, like P_A, perpendicular to $(HL)^P$, will intersect lines through piercing points in the right view, like $(A')^R$, at perspective points, like A^P.

Note that in Fig. 19 end view has been raised above normal position so that perspective obtained does not lie too near bottom of working space.

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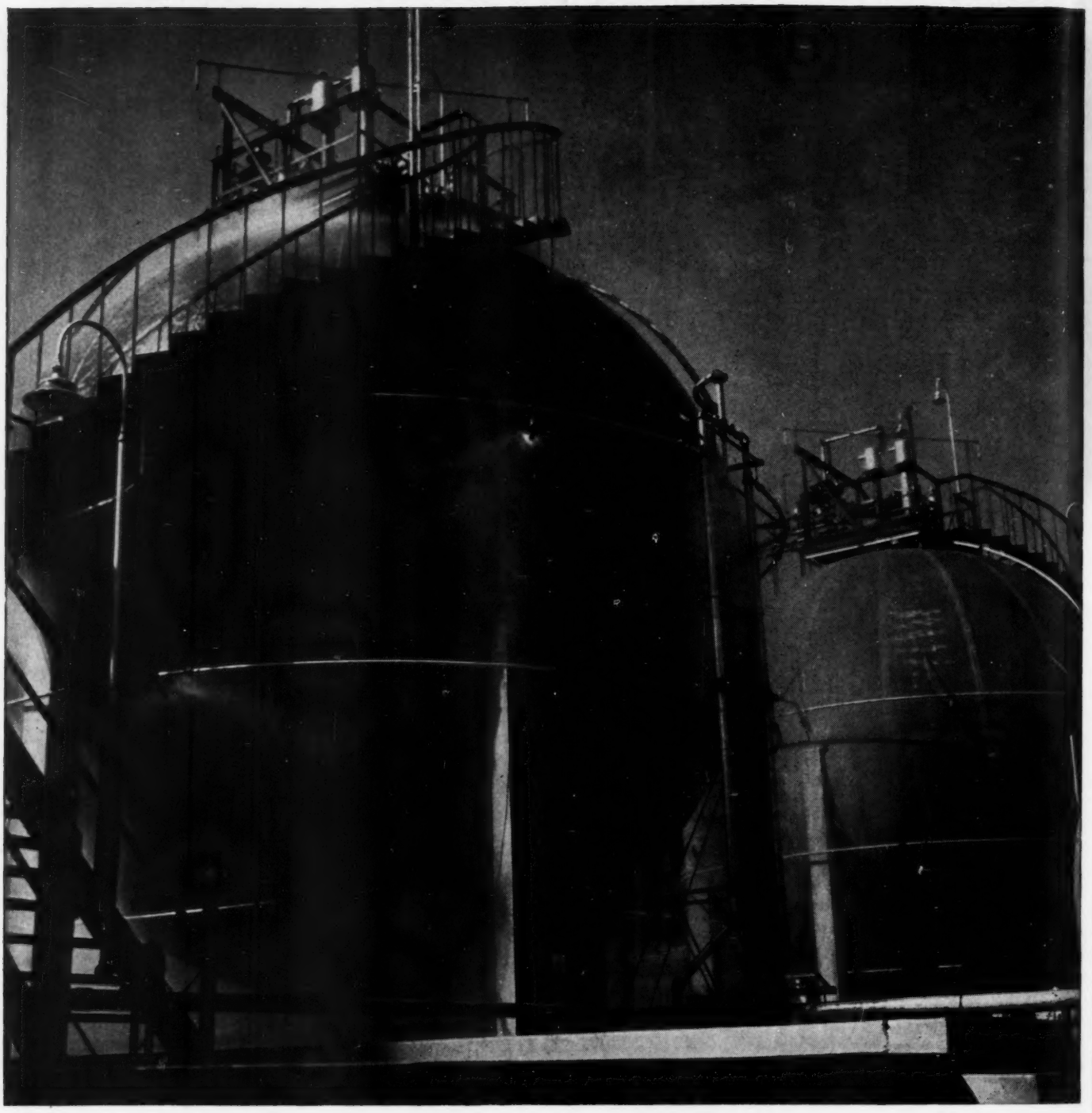

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Aircraft Tool Planning

(*Continued from page* 147)

ordination and establishes all definitely located major attaching points (these may include main beam fittings, rear shear beam fittings, hinge lines, track locations, etc.). It is necessary for the building, duplicating, and coordinating of jigs ranging from those used for small details or subassemblies to the massive steel jigs of the major assemblies. Working from one or several *master* sources this eliminates confusion and *is the solid basis and foundation of all good tooling. The tool planner should hold fast to this ideal.* After tools are built and in use they need frequent corrections and checking, thus the master tool not only serves to build but to keep the tooling accurately aligned.

5. Importance of Part or Assembly

The planner must know the importance of the job to be planned. If it is a detail, he must take into consideration its use in the assembly, whether it is a simple support, an important contoured section, or one that carries load. In all cases efficient tooling is of prime importance and the job must be conscientiously thought out first before ordering tooling.

6. Forming Quality of Specified Material

Every engineering print specifies the material from which the part is to be made. From this callout the planner can plan his tools, not only to form the part but also form it with regard to the special specification of the material. If a soft heat treatable material is to be formed, the heat treating and warping effects must be considered. Should warp be serious, reforming immediately after quenching may be necessary to reset the metal. If material is the non-heat treatable type then its work hardening qualities must be considered. In deep draws, several annealing processes may be necessary. Constructive thought for future work should be turned toward the use of "SW", ice-box materials, which would greatly decrease warpage problems.

7. Necessary Jigging

The proper type and construction of jigs calls for considerable thought and vision. The jig serves a definite purpose in that parts are held, and/or holes drilled, so that details may be attached together, or assemblies mated to each other. Jigs constructed of wood are generally used for small assemblies—are used for major assemblies only on the experimental ships of a new model. Wood jigs are low cost tooling, requiring a short time to construct and using an inexpensive material. Caution must be observed in selecting wood jigs, determining first the type of job they are to perform, and secondly the number of parts or assemblies handled. Wood wears out quickly if not handled properly, and drill bushings become loose, losing accurate location.

Jigs constructed of dural are quickly replacing wood jigs. Dural is worked nearly as easily as wood, is stronger, and wears better. Dural has its limitations in that bushings come loose; but like wood jigs, dural jigs are sufficient for small work. They should not be used where accurate interchangeable holes are drilled in large numbers, or for jigs of major assemblies. Steel jigs are the most satisfactory for accuracy, maintenance of location, strength, wear, and mass production. Steel's drawback is in its expense; *a tool design is needed on steel jigs, the working and cost of steel itself is expensive, and steel is a priority item today.*

Importance of the job must be considered before ordering too many steel jigs. Should the detail or assembly be small, but its location or hole layout important, then steel jigs are necessary. Large steel structures are necessary to support major assemblies, thus weight is another of several points to consider.

Keen judgment, knowledge of jig construction and costs, complete analysis of the job, and experience, are the best guides in deciding upon the best planning procedures. Whether to use an assembly jig, drill jig, or assembly drill jig, reverts back to the type of coordination planned, the importance of the detail or assembly, the assembly location, interchangeability, and the ultimate unit cost.

8. Assembly Location

In planning an assembly, consideration must be given to the importance of holding various positions of the structure. The over-all length of a structure must be definitely held, attaching fittings located, skin, stringer, and longeron stops provided, hinge lines determined and maintained, chord and dihedral references held, contours controlled, track locations specified, etc. Each point must be ferreted out by the responsible planner. This item should be considered first as part of the whole structure, then secondly as a separate unit.

9. Complicated Assembled Structures

In major assemblies there are areas, within the structure, that are inaccessible. Subassemblies of these areas handle this problem. Building of various

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subassemblies break it down, eliminating a hetero-geneous collection of details that would have to be assembled, thus complicating the assembly jig. Subassemblies speed major assembly time, make complicated structures relatively simple, and tend toward standardized procedures and more bench work. Hence, coordination comes to play a more important and practical role in the production and assembly of airplanes.

10. Bench Assemblies

Small and compact bench assemblies should either be provided for by engineering design or else can be produced by production assemblies created by tool planning. Bench assemblies lessen major assembly time and reduce the complexity of such. In building these assemblies, a worker has all of his tools and parts concentrated and within reach. Also, by means of adding small assemblies upon small assemblies, the major assembly becomes a fairly simple structure.

The bench worker tends to become skilled at his task and in many cases works out his own methods of assembling which adds to his satisfaction. A man doing a specialized job tends to increase output and quality of workmanship. Thus, by means of small complete assemblies, and the shrewd planning of such, the tool planner can do much to aid production.

11. Production Assemblies

After the program for the current model is under way, or even before, it may be found that if the ship's structure could be put together in a different manner, production could be increased. If subassemblies were made more complete, major assembly work could turn toward the more important work of maintaining coordination and interchangeability.

Production assemblies are created by the tool planner and production engineer and differ from the engineering assemblies in that they make the same assembly either more complete or less complicated than originally designed by engineering. No prints are needed, although illustrations of the production assemblies are desirable.

Production assemblies accomplish the following:

a. Facilitate production
b. Create fewer and more complete subassemblies
c. Reduce "stock" problems
d. Require no engineering print changes
e. Produce more bench assembly work
f. Reduce major and final assembly time
g. Make major jigs less complex in structure

The tool planner must determine when a production assembly is necessary. Some models may not require

RE-LIGHTING
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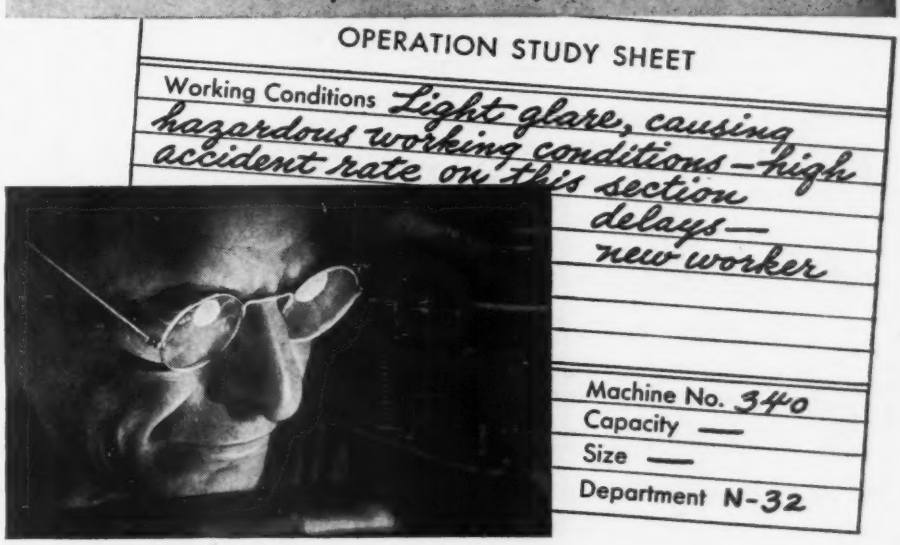

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them because of their simplicity. It must be noted that once production assemblies are made in one portion of the ship they invariably spread throughout. Trouble lies in the fact that production assemblies have no engineering prints of an exact nature and, therefore, when released on a major scale, tend to confuse the assembly lines. With an eye to the future it will be noted that today aircraft engineering and tool planning are working together during the period of the ship's development; all of which means that production assemblies will be a thing of the past as future ships will come from the drawing boards as production products.

12. Design Requirements

Major jigs, fixtures, and steel dies require tool designs. Designs are very necessary and eliminate unnecessary thought and work for the tool maker. It leaves the job of tool making to the man best equipped for that job and tool designing for the man of creative ideas who knows the *entire* problem. On the other hand, many fine jigs, fixtures, and certain types of dies, can be made without tool designs. Designs cost money and require time to make, slowing up the work, since the design must be finished before the jig, fixture, or die can be made.

The following aircraft tools do not, as a rule, require tool designs:

1. Templates
2. Form blocks
3. Drop hammer dies
4. Wooden detail and subassembly jigs
5. Router blocks

The planner must be cautious in calling for tool designs. Should the job require extreme accuracy and that attaching points be maintained, a design of the jig or fixture is essential. Decimal dimensions require the best in tooling and the best tooling requires designs. If a jig or fixture requires few location points and the job is urgently needed, designs at the start may be by-passed. Good judgment, complete knowledge of the job, and logical reasoning with regard to the company policies and experience, should guide the tool planner in deciding upon the advisability of ordering a tool design.

The remaining eight points of consideration in proper job analysis for tool planning will be outlined by Mr. Luders in the May issue of AVIATION.

Aviation's Place In the Controlled Materials Plan

(*Continued from page* 115)

in production methods, the actual requirements often prove less than estimated.

In one case, for example, new methods of working extrusions were so effective that the company found it actually got 162 percent of requirements. In this instance, however, increased production schedules, coupled with delayed deliveries, resulted in all the material being used. Although the case just cited is an extreme, involuntary inventories are the rule rather than the exception in the aircraft industry.

However, for every inventory excess, there is undoubtedly at least one shortage—a plant may find itself long on aluminum sheet and extremely short on certain steels, perhaps just the reverse of another plant.

But, it is pointed out, if applicants for materials submit accurate CMP-4A or B forms, the unbalance will show up on the applications and can be dealt with promptly.

In many cases inventory adjustments have already been made or are currently being made between plants through Aircraft Scheduling Unit district offices.

In addition, the inventory report which was to have been filed on Mar. 31 (the CMP-7 and ASU Supplementary) can be used to disclose any unbalanced inventory conditions.

Nevertheless, many industry representatives are pressing for modifications which will speed re-distribution of materials, and there is every evidence they will soon be in operation. Whether such changes take the form of a "Stock Exchange of Raw Materials" or some other centralized agency to speed redistribution is, to all intents and purposes, largely academic. The point is that WPB officials and industry representatives have worker together, and are working together to set up machinery whereby the industry may not only know at all times what material is available, but will have the means to get it into production at the earliest possible moment.

Adoption of such a plan would go far, it is felt in the industry, to eliminate one of the major criticisms of the plan. That is the necessity for the manufacturer expending vast sums of priceless man-hours in establishing proof of his needs when, in fact, it is sometimes physically impossible to do so. Such a move might result in a second major modification regarding compilation and filing of the all-important Bills of Materials.

It has been proposed that these be simplified by setting up "average planes." This means that the industry, perhaps pooling some of its resources, would make detailed studies of the major types of planes, finally arriving at an "average" fighter, medium bomber, heavy bomber, etc. To find a quarter's material needs for, say a medium bomber, the manufacturer would take the average figures, multiply them by the number of planes called for in his authorized Production Schedule, and the result would be his Controlled Material requirements for that period. If, when he started production of the model, he found some requirements were less than listed, his excess inventory would immediately be made available to the re-distribution agency which could turn it over to a plant whose requirement estimates had been found to be too low.

This plan, of course, might work in cases of some standard shapes and sizes, but would not handle extrusions, forgings and other shapes, nor would it work for steel alloy forms or specific component parts. The end conclusion must be, it is felt, that there is no thorough substitute for accurate Bills of materials.

It should not be inferred that the aircraft industry wants to re-write the Controlled Materials Plan. Such is not the case. Aviation manufacturers believe that CMP is fundamentally sound and that it can be made to work. What they have appeared to want, above all, is assurance that CMP won't be junked overnight, for it is utterly impossible to maintain mass production on "a three months-to-three months basis." An aircraft production line cannot be turned on and off like a stream of water.

This assurance has been given in every WPB utterance, both on and off the record. Board officials point out that the plan has been designed to be flexible and that it will be so administered, taking into account the different industries and strategic requirements involved.

While the principle of CMP is simple, its operation—by the very size of the industries involved—admittedly has had and will have, its rough spots. As a service to its readers coming under the plan, AVIATION presents herewith a summary of some of the most-frequently asked questions, together with answers as worked out by WPB officials sitting in round table discussions with representatives of the armed forces and the aircraft industry:

1.—To what extent, and at what time, will the aircraft industry be involved in other materials as well as controlled materials?

For the second and third quarters only aluminum, steel, and copper will be considered as controlled materials. All others are to be handled as non-

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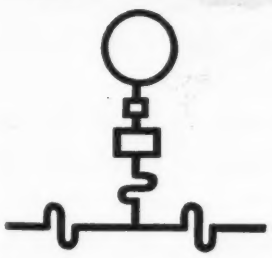

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controlled materials, unless or until advice to the contrary is given. CMP is, however, flexible to permit inclusion of additional materials in the future, if necessary.

2.—What is meant by "program"?

A program is a broad classification of end-products—such as airframes or engines—to be produced in a specified period of time. An Authorized Program is one specifically set up by the Requirements Committee of WPB or a Claimant Agency (such as the War or Navy Departments or the Aircraft Scheduling Unit) or Industry Division within the limits of its total allotment. For the aircraft industry there are two programs: (1) Aircraft and airborne equipment and (2) Ground and deck equipment, facilities, and miscellaneous items not otherwise covered.

3.—What is the procedure under which allotments will be received and extended by a Prime Consumer, who is defined as any person who receives an allotment of controlled material from a Claimant Agency?

Currently, the Requirements Committee divides all available controlled materials into approximately 50 programs. The Aircraft Scheduling Unit, which acts as the working agency for the Aircraft Resources Control Office, subdivides these programs on the basis of the applications received from prime consumers, and each consumer will receive an authorized production schedule for each production line or model of aircraft, together with allotments of controlled material required to fill these schedules. Advance allotments for the third and fourth quarters of this year are also being made up to specified amounts. These production schedules may not be the same as the current contracts, but they will be based on them as closely as possible.

Under CMP, the entire responsibility for completing the finished product rests with the prime consumer. He furnishes the Bill of Material and the application to build a specific part of an over-all program and the Claimant Agency provides him with the total allotment to complete the authorized schedule. The prime consumer may then deal with secondary consumers (such as subcontractors or sub-subcontractors) in the most efficient method to meet his requirements. He may either fabricate all the products of the authorized schedule himself, or he may farm out part of the schedule to secondary consumers. But whenever a portion of the primary consumer's schedule is extended to a secondary Class A consumer, it must be accompanied by an allotment of controlled material.

Originally, CMP procedure specified that this allotment be authorized by extension of the full allotment number containing the identification of the Claimant Agencies, the program number, and the prime consumer's specific schedule. It was found, however, that for many manufacturers this procedure was too cumbersome and involved too much paper work. In addition, many products sold to a large number of customers were classified as "B" products as a result of the complicated procedure for handling "A" products. To overcome these complications, it was decided to grant prime consumers their allotments of controlled materials on a quarterly basis instead of monthly. The authorized production schedule, though, is issued by months. Since no consumer may purchase controlled materials in greater quantities or at a rate faster than necessary to meet his schedule, orders for controlled materials are to be specified for delivery as required.

Second important step in simplifying procedure for handling "A" products lies in the extension of allotments. Agencies thus issue the full allotment number to prime consumers in order to allot a specific quantity of material to a specific production schedule. In extending allotments for secondary Class A products and for controlled materials, the prime consumer merely extends the major program number and quarter digits. All delivery orders for aircraft products may be grouped under the two aircraft programs rather than by extension of each allotment number individually. Since most aircraft producers will have ten or more allotment numbers, extension of the program number alone will greatly simplify accounting records and other paper work. With each authorized production schedule, the prime consumer receives a preference rating to be used for procurement of Class B products and non-controlled material required to meet authorized production schedules.

It is advantageous to extend the program number along with the preference rating since, under CMP, preference ratings with a program number are granted preference over all other equal preference ratings. However, the preference rating received with the authorized production schedule should only be used to secure production materials, and should never be extended for the maintenance, repair or operating supplies. A separate rating is provided under CMP Regulation No. 5 to secure such supplies.

Responsibility for completion of the production schedule for individual procurement items is vested solely in the prime consumer. This responsibility carries with it the necessity of maintaining close relations with secondary

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consumers to make sure their bills of material and applications are accurate and that each secondary carries out his part of the production.

4.—Does the term "maintenance spare parts" mean "prime contract spares," "short order spares," or both?

Maintenance spare parts are those purchased on separate contracts (short orders). That is, they are the spares required to maintain aircraft already produced.

5.—What is the procedure for securing material to manufacture spare parts?

Application for material to manufacture spare parts which are to be delivered concurrently with completed aircraft should be included with production requirements. And both should be requested on form CMP-4A, the Application For Allotment of Controlled Materials For Class A Products. Requirements for maintenance spares, which are generally procured on separate contracts, may be applied for by filing a separate CMP-4A covering requirements for maintenance spares only.

6.—Will the Aircraft Scheduling Unit make use of long range forecasts included in CMP, reporting for quarters subsequent to the quarter directly involved? Wouldn't it be adequate simply to report actual requirements for one quarter and abandon the use of so-called "information" reporting which, after all, merely reflects a trend already well defined?

The purpose of including requirements on forms CMP-4A and B for more than one quarter is to enable the Claimant Agencies to make advance allotments, thus reducing paper work and enabling a manufacturer to place delivery orders which will cover a longer production period. It has been found impractical to base allotments on past usage, since a single quarter's requirement must be adjusted to the authorized production schedule as well as inventory, and therefore cannot be used as a base for establishing a trend.

7.—If a manufacturer's inventory is unbalanced or insufficient to maintain operations at practical production levels due to material allocation cuts or unfilled orders at the mills, what provision will be made to secure enough of this material to bring inventories up to a sound operating level?

Some manufacturers have already placed purchase orders with the expectation of replenishing inventories or building them up. In filing CMP-4A or CMP-4B (Application For Allotment Of Controlled Materials For Class B Products) for, say, the third quarter, there arises the question of whether the backlog of unfilled purchase orders calling for delivery in, or prior to, that quarter should be included with production requirements. In filing CMP-4A and B applications for the third quarter, the manufacturer should include only the controlled materials required for his authorized production schedule, for provision has been made on both forms to take account of inventory adjustments.

In designing these forms it was considered that, because of inventory reserves, actual current material requirements would frequently be less than production requirements as listed on the Bill of Material. They do not, however, anticipate substantial replenishment of inventories beyond quantities required to cover authorized production schedules. Substantial requirements to rebuild inventories within a short time could obviously be met only by reductions in authorized production schedules.

Upon receipt of a controlled materials allotment, the manufacturer should extend the program number to his outstanding purchase orders, bearing in mind that program numbers may not be extended for more material than has been authorized in the CMP allotment. This, of course, will not correct a deficiency in inventory. But, immediately after the close of say, the second quarter, when each prime and secondary consumer can know what deliveries have been made by mills in the previous quarter, a re-determination of any inventory deficiency may be made. Prime consumers should obtain reports of inventory deficiencies from their Class A secondary consumers.

Then there should be directed to the Aircraft Scheduling Unit a supplemental CMP-4A application, plainly marked "supplementary application for materials to restore inventories to minimum effective working level." This application should specify minimum additional controlled materials needed to bring deficient inventory items up to practical working levels. Each supplemental application should be accompanied by covering letter which fully substantiates the need for the additional inventory requirements.

It is patent that large quantities of materials to rebuild inventories will not be available between now and the end of the second quarter; it must be anticipated that rebuilding can be accomplished only over a period of time. Meanwhile, manufacturers should investigate all outstanding orders, looking toward elimination of all that have become obsolete or are duplicates.

It should be emphasized that all supplemental applications will be given consideration by the Aircraft Scheduling Unit and its report, together with recommendations, will be made to the WPB for steps as may be taken to correct situations needing adjustment.

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8.—*Assume that a manufacturer develops a built-up section to replace a heavy extrusion, but that final development work and tests are not completed until after filing of Bills of Materials—then if it proves practical to build the part of sheet, may the company so notify the Scheduling Unit and have its production schedule increased, provided it had been cut due to a shortage of extrusions?*

If it is known that a substitution is being made for a critical item the production schedule would not be reduced in the first instance. However, if the production schedule had been cut only because of limiting factors as described in the question, the schedule might be increased as soon as a suitable substitute was available.

9.—*In case a substitute—say fabric for metal aileron covering — doesn't work out, may the manufacturer apply for additional quantities of metal or must he reduce his production schedule?*

It will not be necessary to reduce the production schedule. The manufacturer should submit a supplemental CMP-4A for the original material, in this case metal. Small quantities of controlled materials will be withheld for emergency distribution to cover such situations. The manufacturer should however, do his best to anticipate difficulties in securing or working with substitute materials to provide the Claimant Agency with as much advance notice as possible.

10.—*How will a manufacturer apply for controlled materials and fabricated parts to build experimental planes and to conduct research on other experimental equipment?*

For experimental aircraft or special projects calling for substantial quantities of materials, the manufacturer must file individual CMP-4A applications. Engineering estimates may be used to determine the material requirements. For usual research and experimental projects calling for various materials in limited quantities, the manufacturer may file a single CMP-4B, but a covering letter describing the field of experimental work should be attached.

11.—*If a manufacturer, in his applications, classifies parts or assemblies as Class B products when they are actually Class A, what is the procedure to secure an additional allotment to correct the situation.*

He should then file a supplemental CMP-4A application to secure an additional allotment to cover this requirement. Care should be taken not to file a CMP-4B application, as it would automatically be rejected by the appropriate industry division.

12.—*Since controlled materials producers are permitted to ship at any time during the eleven-week period between the 15th of the month preceding the allotment month and the last day of the month following the allotment month, won't consumers be forced to maintain larger inventories to absorb possible deviations from shipping schedules?*

In the interests of maintaining maximum production of controlled materials, producers have not been forced to restrict rolling cycles within an inflexible 30-day period, as this might seriously curtail output due to loss of production time in unnecessarily frequent set-up changes. Nevertheless, controlled material producers must refuse any order for shipment in any month if that order, together with authorized orders already on hand calling for delivery during that month, plus any authorized orders carried over from the preceding month, total 110 percent of the producer's production directive for that particular product. This over-allotment to producers will be adjusted up or down to keep mills at full capacity without allowing backlogs to accumulate. Controlled material producers must, however, make delivery of each authorized order as close to requested delivery date as possible. They are obligated to ship within the month promised, unless unforeseen conditions make it impossible.

In some cases, producers' schedules may necessitate delivery up to 15 days ahead of the specified month, but it is felt this will not create a hardship for the consumer. But while the majority of controlled material orders can be delivered in the month specified, a producer may be unable to complete delivery on some orders until the following month. In such cases, he must notify the customer as soon as it is evident that delivery cannot be completed in the month specified. Then, if such delay will interfere with the customer's authorized production schedule, he should apply to the Aircraft Scheduling Unit for relief.

If, after accepting an authorized controlled material order, a producer is unable to make delivery by the end of the month following the month specified, he must immediately notify the Controlled Materials Division so that it may take action to meet delivery requirements. Suppose, for example, a steel producer accepts such an order with delivery specified for June but finds shipment cannot be made until after July 31—then he must promptly advise the Division, which will take steps to insure that the manufacturer gets the necessary steel.

The maximum 60-day inventory, established under CMP Regulation No.

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2, is considered adequate to provide for most deviations in deliveries which will be encountered.

13.—*When allotment numbers are issued, consumers naturally will rush to place orders with producers. What machinery will control the distribution of these orders, and how will it be done?*

CMP Regulation No. 1 has been amended to assure distribution of the quarter allotments to the months within that quarter so that the first two months won't be over scheduled. Thus for steel and copper, not more than one-third of the quarterly requirements may be placed in the first month, nor more than two-thirds in the first two months. For aluminum, the ratio is 30 percent for the first month and 63 percent for the first two months. All other materials should be ordered consistent with authorized monthly schedules and in support of the allotments just mentioned for controlled materials.

14.—*How do modification centers obtain their requirements of controlled materials?*

A center operated by an aircraft manufacturer will get its materials through a separate CMP-4A application filed by the manufacturer. A center operated by an airline, or management other than a manufacturer, is also classed as a prime consumer and therefore will make application direct to the Aircraft Scheduling Unit, using form CMP-4A.

15.—*May large subcontractors be considered prime consumers rather than secondary consumers as at present?*

A subcontractor is a secondary consumer regardless of size. The Controlled Materials Plan uses vertical allocation—to the prime consumer and through him to others—wherever possible. This is done so that final responsibility for all phases of production rests with the producer of the end product, that product, in this case, being complete aircraft.

16.—*Do subcontractors, or secondary consumers, report their inventory position to prime consumers when submitting bills of material? Also, how much responsibility must the prime consumer assume for verifying the secondary consumer's inventory and the use of materials procured by the secondary under the prime consumer's allotment number?*

Inventory positions are not reported on bills of material. However, secondary consumers will take their inventory positions into account when applying to the prime consumer for materials to meet an authorized production schedule. As to responsibility: The prime consumer is charged with seeing that his secondaries produce their authorized schedules with the materials allotted them.

17.—*What are CMP provisions for*

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EVERY DAY the saving of manpower in aircraft assembly becomes more important. So it is only natural that aircraft manufacturers are fast turning to Morrison Stitchers which consistently *save hundreds of man-hours per week per machine* in assembling Aluminum, Stainless Steel, Plastics, Rubber, Cork, Asbestos, Wood, Canvas, etc.

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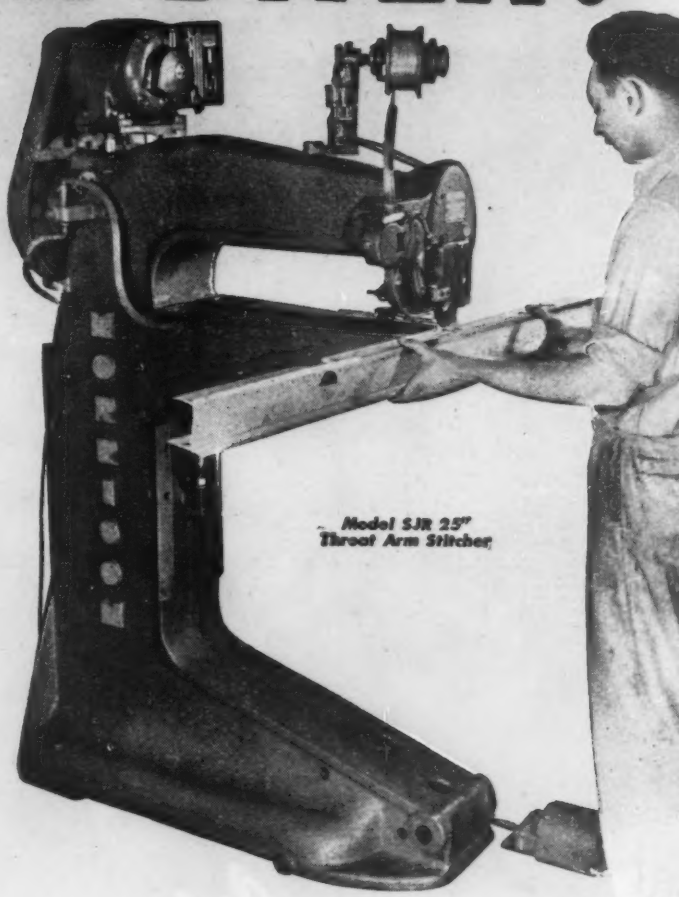
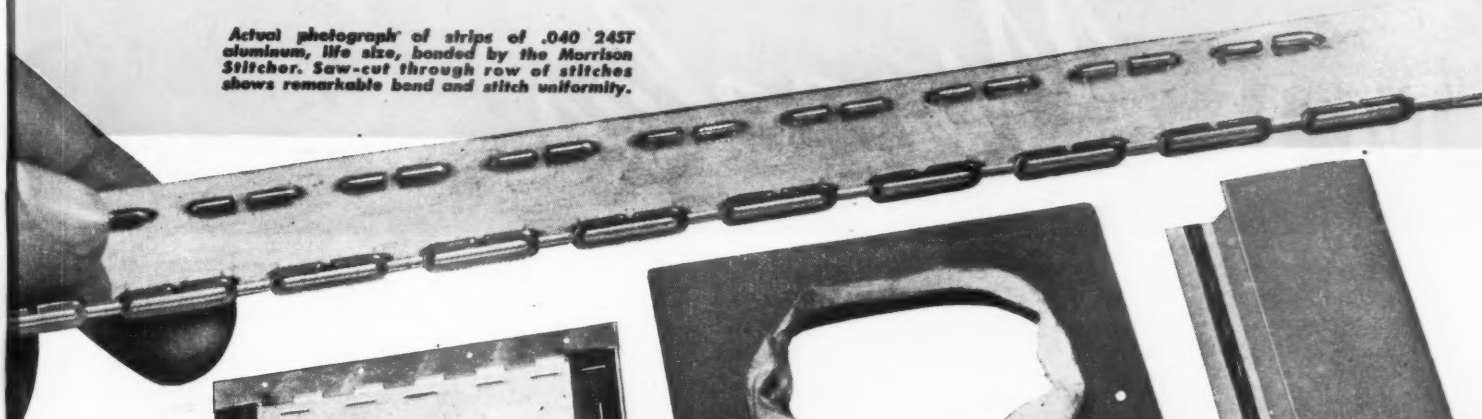
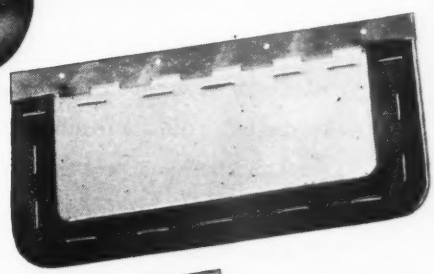


Model SJR 25" Throat Arm Stitcher

Actual photograph of strips of .040 24ST aluminum, life size, bonded by the Morrison Stitcher. Saw-cut through row of stitches shows remarkable bond and stitch uniformity.

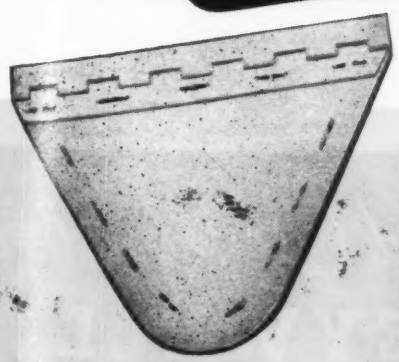




Rubber stitched to .040ST Aluminum

.032ST Aluminum stitched to linen fabric

Fabric stitched to .040ST Aluminum



.040ST Aluminum stitched to .032ST Aluminum

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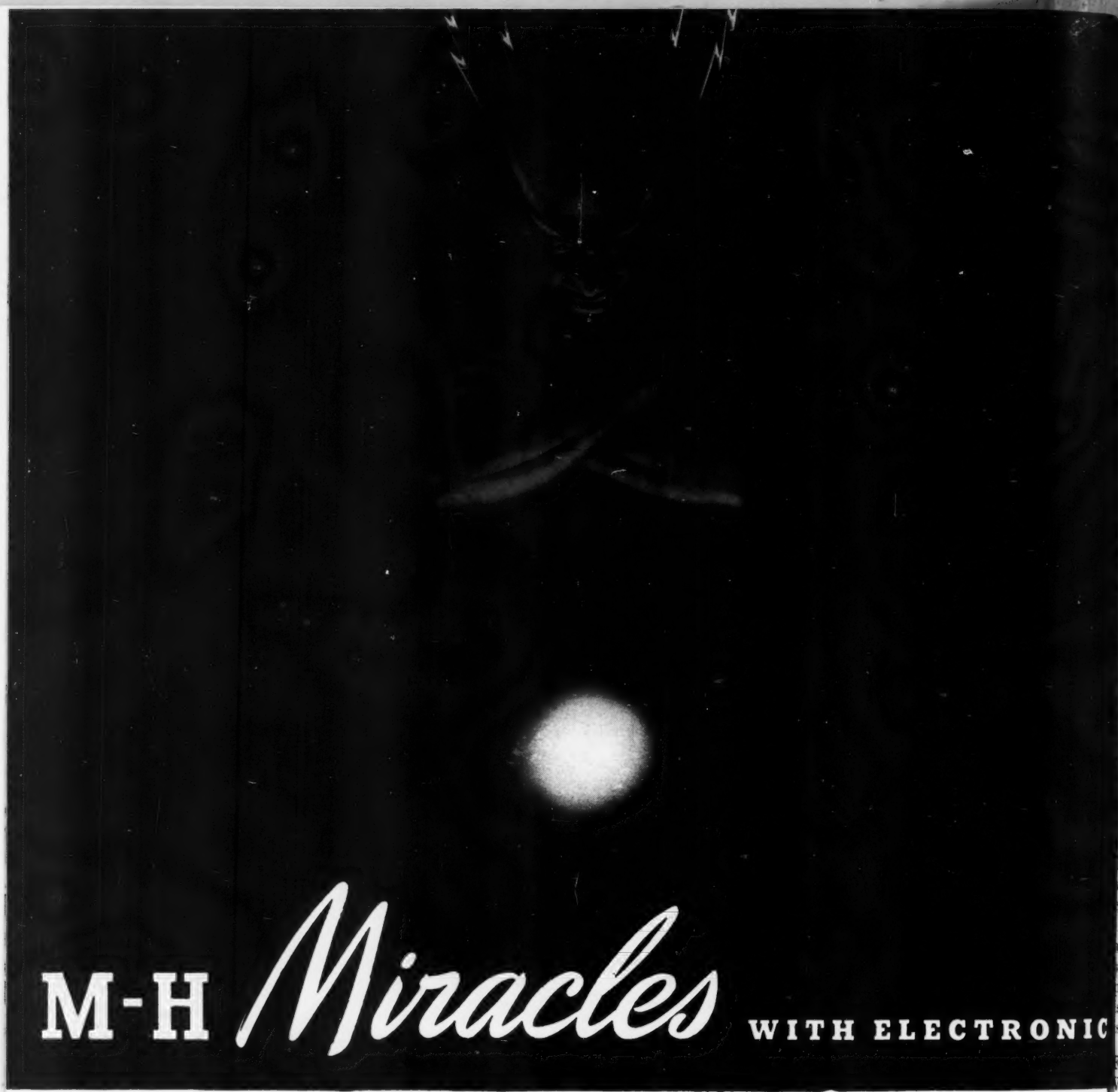

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securing materials and equipment whereby a manufacturer may fulfill a contract to train Air Forces enlisted personnel in aircraft and engine mechanics?

Prime contractors holding such contracts must file material requirements on forms CMP-4A and equipment requirements on CMP-4C for "A" items, and PD-1A for "B" items, except for equipment items of less than $500 unit value, which may be secured as operating supplies under CMP Regulation No. 5. Such applications directed to the Aircraft Scheduling Unit should be accompanied by a covering letter fully describing the training program. Requirements for training Army and Navy personnel should never be combined with materials and products needed for production, which are applied for on a bill of Materials or the CMP-4 form.

18.—*Should requirements for controlled materials and fabricated products arising from employee training programs be included in Bills of Materials, CMP-4A, or "B" applications?*

No. Training programs are usually conducted with secondary material. But if training cannot be given with such material, requirements should be filed on separate CMP-4A applications.

Proper Care of Compressed Air Plants

(*Continued from page* 180)

for the power cylinders. Oil used in compressors of single-acting trunk piston type must be adapted to both compressor cylinders and running gear and must be of the type known as compressor cylinder oil with proper specifications for the machine. Double acting piston type compressors, where frame running parts are separated from compressor cylinders, require cylinder oil for compressor and crankcase or bearing oil for running gear (Fig. 3).

When filling mechanical lubricators prior to starting, break the oil line joints nearest the cylinders and crank lubricant by hand until oil appears at the joints. This will insure an immediate oil supply when lines are re-connected and machine is started.

Compressors vary too widely in type and use to be covered by any one oil specification. However, one of the Compressed Air Institute specifications which is most applicable to a majority of types is as follows:

Flash point.....350 deg. F., minimum
Viscosity S.S.U. at 100 deg. F.....
.....245 minimum
Viscosity S.S.U. at 210 deg. F.....
.....45 minimum
Pour point.....35 deg. F. max.
Neutralization No. .....0.10 max.
Conradson carbon residue.....
.....2.0 percent max.

Steam cylinder requirements will vary according to steam temperatures. For moderate temperatures, the Compressed Air Institute gives the following specifications:

Flash point.....500 deg. F. minimum
Viscosity S.S.U. at 210 deg. F.....
.....Seldom less than 100
Pour point.....80 deg. F. max.
Conradson carbon residue left on evaporation .....4.5 max.
Compounding .....0 to 12 percent max.

The accompanying table gives minimum feed rates under good conditions, to be varied according to conditions and results of cylinder examination.

In the case of gas compressors where the gas has an affinity for oil, the latter must be selected and fed accordingly. If cooling water is at a much lower temperature than the intake air or gas, condensation may take place on cylinder walls, causing poor lubrication. In this case the cooling water should be heated close to temperature of the intake air or gas (Fig. 4).

Ratio of initial and final pressures developed in the cylinders, as well as size and speed, has an important bearing on oil selected. In all cases, judgment should be made on examination of cylinder walls, which may be done by removing a valve and using a flashlight. New machines require more liberal feed. When cylinders are well glazed the feed may be cut back, always providing enough, but not an excess to get in the discharge.

Rotary and centrifugal compressors and exhausters have entirely different requirements, which are specified by the manufacturer. These types need bearing lubrication only. Large and high speed units usually have pressure lubricated sleeve bearings. Follow the manufacturer's recommendations.

In general care of compressors, it is advisable to keep an engine room log recording operating data taken at specified intervals during the day. Daily, weekly, and monthly inspection routines should be established to cover cooling system, lubrication, valves, and packing. Instead of continual running of the compressor until major overhaul is needed, make periodic inspection to catch trouble before it develops. Valves should be removed and examined every six months, or every two if the machine is used around the clock. In proper oper-

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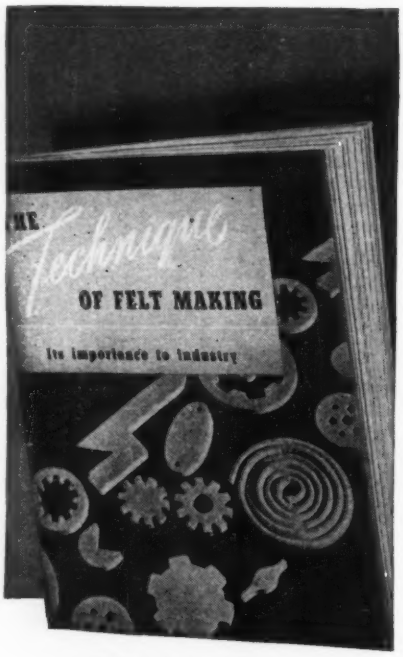

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ation, the valves should have an oily surface and be relatively free from carbon. Each valve assembly should be kept separate and parts not interchanged. In replacing gaskets, be sure that the water ports correspond with those in the head. Conscientious care of this kind will repay in longer life of equipment, fewer interruptions of service, and lower cost of compressed air.

Proper design and installation of air lines have as much to do with efficiency of the system as good maintenance of the machinery. Beginning at the intake, it is important to draw in air as cool and clean as possible. The weight of air handled by a compressor varies inversely as the absolute temperature of the intake. If this temperature can be reduced from 80 deg. F. to 60 deg. F., the compressor will have about $3\frac{3}{4}$ percent more capacity. Dust and grit continually sucked into the machine means high maintenace cost and interruption of service. Therefore choose your intake location carefully, away from smoke stacks, railroad lines, or any constant source of dust.

Good filters should be installed on the intake, with regular cleaning stipulated by the log. The intake should be outside the building where the air is as cool as possible, on the north side rather than the hot side. Sometimes an intake near the roof is indicated in a particular location. If placed lower down, the pipe should be turned upward with the intake at least 10 ft. above ground in order to avoid surface dust. Weather protection must be included to prevent rain or snow from entering the pipes (Fig. 5). Intake piping should be as short and direct as possible, using long radius elbows on all turns. If not over 12 ft. long, intake pipe diameter should equal that of opening into compressor cylinder. If longer, it should be the next size larger.

Need for thorough cleaning of these suction lines cannot be stressed too much. Make certain it has been properly done —rags and debris are found too often to forget this.

Where a large cement tunnel is used for a suction line, it must be glazed and surface treated to prevent cement dust from being drawn in with the air. Above ground, pipe should be standard steel or spiral riveted. Below ground, it may be vitrified clay with cemented water-tight joints.

Discharge lines need to be of good size, for lines which are too small cause an excessive pressure drop. Large pipelines are especially desirable with long lines. Sharp bends increase friction and should be as few as possible.

Water in the discharge lines reduces efficiency and may cause serious damage to pneumatic tools. Aftercoolers are installed to remedy this. Their effectiveness depends on the temperature of the cooling water, which should be as low as possible to prevent any further cooling in the lines from bringing added condensation. If the aftercooler temperature is low enough, this will not occur (Fig. 6). The aftercooler should be close to the compressor in order to receive the air at its hottest, giving a maximum temperature drop in the cooler for maximum condensation.

The receiver handles momentary peak pressures and also eliminates pulsations in the air lines, giving a steady mean velocity through them. As a result, the lines beyond the receiver may be smaller than the line between receiver and compressor, which should never be choked down. Receivers should also be installed in the various departments where the air is used, if these are at some distance from the compressor, to assure a constant supply of dry air.

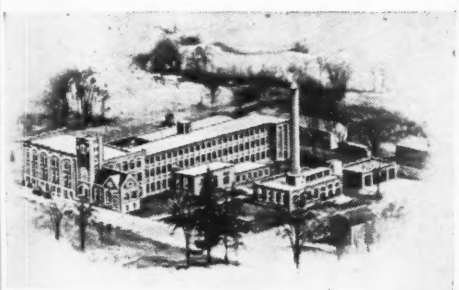
All receivers have drain cocks at the bottom which must be drained daily. If no aftercooler is in the system, they should be drained several times a day, particularly in damp weather (see Fig. 7). Receiver safety valves should be tested occasionally by lifting the levers, or by raising the pressure above valve setting.

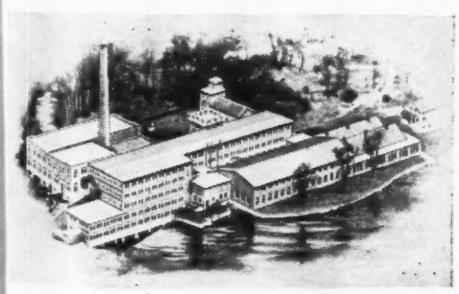
A shut-off valve must never be put in the line between compressor and receiver without a safety valve on the compressor side of it. Likewise, there must be a safety valve between the compressor and the first shut-off valve in the pipeline, if the compressor is connected into an air main with other compressors (see Fig. 8).

Air hose connections should be made from the top of distribution lines to avoid picking up any possible moisture lying in them. Lines should be blown out before connecting to pneumatic tools. High pressure couplings are required on most lines. For proper maintenance the hose should be occasionally turned end for end, and it should be kept on racks when not in use.

Leaks in the piping system are perhaps one of the most common and also most easily corrected losses in a compressor plant. They are usually not hard to find, due to the noise of even a small escape of air. The financial loss from leakage can assume considerable proportions. Leakage of air at 100 lb. pressure through a single $\frac{1}{8}$ in. opening would add up to about 6,000,000 cu.ft. per month. At 6c. per 1,000 cu.ft. this would cost $360 per month. Air lines should be tested when the plant is not in operation by packing the lines and shutting down the compressor to see how fast the pressure drops. The noise is as good a guide as any for serious leaks, although a lighted candle is sometimes helpful. Small joint leaks around joints can be bubble checked by liquid soap.

Our Battle Flag!





NOW a new battle flag flies over the two Ellis Mills here in Monson, and every Ellis worker proudly wears a new badge of honor. For Ellis has been awarded the Army-Navy "E" burgee for outstanding production, and Ellis employees the "E" pins for unusual devotion to duty in time of war.

Of course, Ellis workers have always been proud that since 1863 their product has been recognized as the finest cloth used for uniforms and officers' overcoats — that today 100% wool overcoats from their looms are a preferred choice among officers of Army, Navy, Marine Corps, Coast Guard, and Maritime Commission.

And in peacetime, Ellis workers were proud that their craftsmanship won first choice for upholstering fabrics for America's finest automobiles and airliners. They hope it will not be long before their looms will again be busy weaving fabrics for the fine cars of the future, and for the transoceanic clippers that will revolutionize world transport of tomorrow.

But meanwhile, we all get a special thrill from having been chosen by the Marines to supply standard olive green uniform cloth for our gallant "devil dogs" of every rank. Our best is none too good for the U. S. Marines — now and every day henceforth — until the final moment of the enemy's unconditional surrender. Until then our battle flag will fly.

All of us at Ellis pledge the Army and the Navy that six months hence we will merit an added star for continued high performance.

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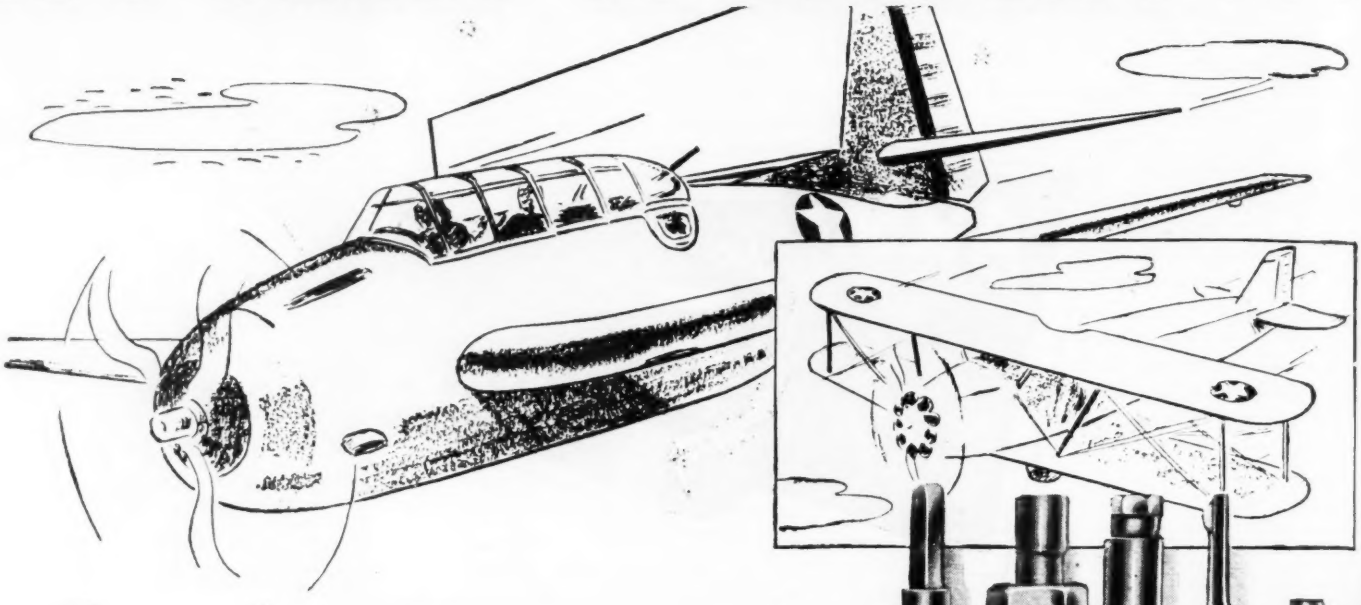

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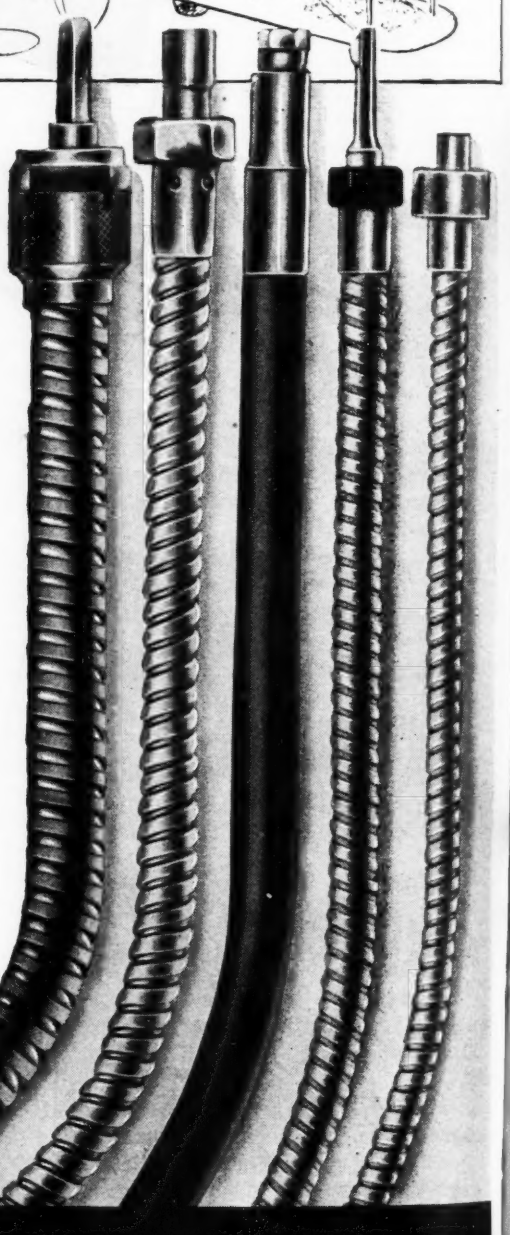

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When our bombers take to the air—whether to rain destruction on vital enemy bases, or to support ground-force attacks—the odds are heavily in their favor. These bombers are made safer for their crews and give greater protection to all of our forces involved in the engagement, because they are protected by power-operated revolving gun turrets, one of the war products made by Emerson-Electric.

More than 53 years' experience in precision workmanship, building millions of high-quality electric fans, motors for appliances and equipment, and welders for industry, was quickly converted by Emerson-Electric to the manufacture of gun turrets and other war equipment. The same all-out dependability which has made these fans, motors and welders so outstanding now contributes to the safety of our armed forces.

Now, everything Emerson-Electric makes is for the military and naval needs of the United Nations.

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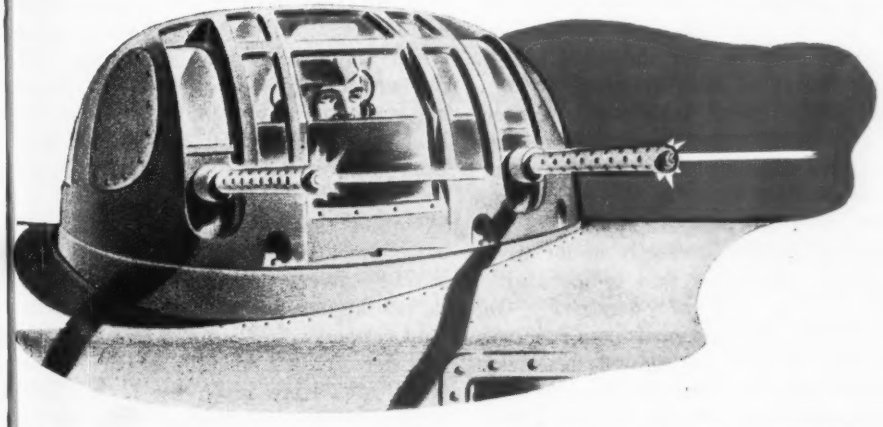
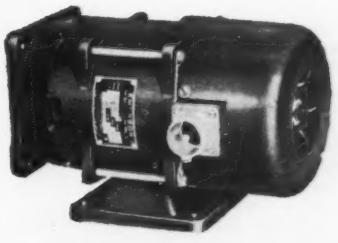
For building these Power-Operated Revolving Gun Turrets and other war products, Emerson-Electric workers were presented with the Army-Navy "E" Award — in recognition of their "patriotism and great work . . ."



How *Emerson-Electric* Power-Operated Revolving Gun Turrets Work

These turrets might be called "built-in fighter escorts" because they protect the plane and the members of its crew while they are engaged in offensive missions. The gunners inside the turrets (a single bomber has a number of power-operated turrets) are well protected while they "dish it out" to enemy aircraft. In a split-second they can swing into position and cover the point of attack with a continuous burst of fire power from heavy-caliber guns.



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And just as Wiry Joe automotive cable won a name for quality, so, too, has Wiry Joe aviation cable. Every item in the line is built to meet rigid Army and Navy specifications, and is produced under the Dostam method of manufacture for uniformity, dependability, high efficiency and long life.

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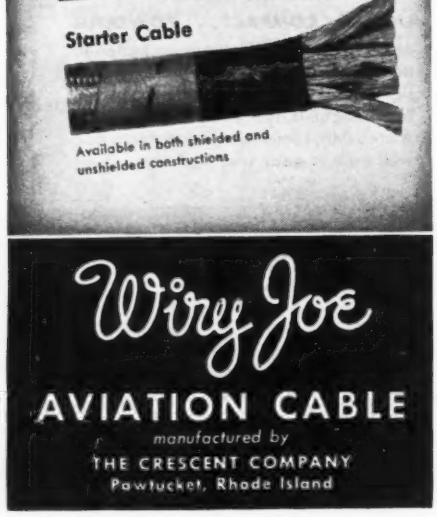

Wiry Joe
AVIATION CABLE
manufactured by
THE CRESCENT COMPANY
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S.A.E. Holds 38th Meeting in Detroit

(*Continued from page* 177)

prediction were also reminded of future political problems by Arthur W. Herrington, retiring president of SAE, chairman of the Marmon-Herrington Co., and a director of Consolidated Aircraft Corp. In his remarks introducing the principal guest speaker, Maj. Gen. Levin H. Campbell, chief of Army ordnance, Mr. Herrington castigated isolationism as "a positive step toward national suicide" and called for "a dominant aircraft industry . . . which will guarantee for us the might necessary to make our voice heard in the world to come."

Engines and Materials

During the five-day meeting, 48 papers were read. Nine of them directly concerned aviation, and four of these dealt with engines and the materials used to make them.

In introducing his paper on *Carburetion for Aircraft Engines,* Frank J. Wiegand (Wright Aeronautical Corp.) pointed out that many suspected carburetor faults actually arise from troubles in fuel and ignition systems, cowlings, superchargers, and propeller governors. Fuel mixtures, he said, cannot be maintained closer than ±2 percent. They vary with flight requirements (lean for peaceful cruising, rich for belligerent power-operation). Air intake, he continued, should be measured in pounds, not cubic feet, and for most power this inhalation should be 5.9 lb. an hour for the indicated horsepower output of each cylinder.

But in practical tests the engineer is beset by a number of human and mechanical errors which affect his data. The carburetor itself is a compromise, compressed into a small space and required to function perfectly under various flight conditions and temperatures ranging from −67 to 180 deg. F. On test flights, metering variations increase with altitude and consequent necessary mixture changes. The obtaining of successful metering information, he went on, thus depends much upon the skill of the engineer. Present carburetors will not meter closer than ±5 percent over the entire engine range.

Careful checking has enabled United Air Lines to come within 1 percent of this ±5 range, Ray Berry, one of its representattives, reported at the conclusion of Mr. Wiegand's discussion. He pointed out that a saving of 2½ percent in fuel consumption increases payload 8 percent.

A review of power plant testing practices in modern laboratories was presented by Charles Lipson (Chrysler Corp.) in a paper on *Methods of Stress Determination in Engine Parts,* which described the use of direct means of measurement in place of formulas. Chief among the devices used for this purpose were electric strain gages, photoelastic equipment, extensometers, and lacquer coatings. In the latter case, lacquered plastic models of parts were put under stresses which were analyzed under polarized light from the fractures in the surface coating. For the electric strain test, a fine wire was attached to the part. Strain upon it had a measurable effect on the amount of current passing through the wire.

Answering a question on the reliability of the data, resulting from these various tests, Mr. Lipson said the wire gages were accurate within 2 percent, the photoelastic tests within 10 to 15 percent. "Compared to automobile work," he added, "the factor of safety has to be greater, but in the design of engine parts we would like to hold it to 1."

Substitutes

New types of steel alloys for engine parts to conserve the supply of nickel, chromium, molybdenum, vanadium, and tungsten were described in a paper by M. H. Young and H. Hanink (Wright Aeronautical Corp.) . They also reported on the use of plastics and synthetic rubbers. These substitutes, developed from need rather than because of their innate suitability, have peculiar stress and temperature limitations, and the writers urged caution in the choice of synthetic rubbers. They must be heat- and oil-resistant and at the same time unaffected by high altitude temperature drops.

Out of the loss of tin, however, has come one more-than-satisfactory substitute—silver. As a bearing material, it has higher fatigue strength, greater load capacity, and is no more expensive. Further details on the search for tin substitutes were given by L. M. Tichvinsky, senior mechanical engineer of the naval engineering experimental station. He reported that tin and silver or arsenic alloyed lead base babbitt had been found to possess great resistance against the corrosion likely to occur at high oil temperatures.

Comparative advantages of electric and hydraulic systems were analyzed in an unprinted paper on *Accessory Power for Aircraft* by Lt. Col. T. B. Holliday of the Army Air Corps. Asking for greater use of electrical systems, Col. Holliday pointed out that on the basis of a complete installation they weigh only half as much as hydraulic equipment and are 60 percent efficient

as compared to 25. Electric power transmission, he said, is also less easily interrupted and with only limited consequences. Electricity will become even more efficient and require still lighter conductors as voltages are increased in large planes, probably up to 220 v. a.c., which should be supplied by generators on each engine. Electric brakes are also being developed, but there is no definite information on them yet.

Notes on *Production Application of Flash Welding* by Robert N. Milmoe (Lockheed Aircraft Corp.) were presented by Edwin M. Davis of the same company. Lockheed has been using flash welding almost exclusive to connect thin walled SAE 4130 tubing to forgings and castings. Increases in the pressures of standard flash welding machines and changes in current timing were necessary to handle this kind of work, but the most important procedure was the proper placing of pieces in the machine. Electric eddy currents were found to be fairly satisfactory for testing unions.

Solutions of problems in maintaining passenger comfort during two years' commercial high-altitude flying were analyzed by R. L. Ellinger (Transcontinental and Western Air). He mentioned the difficulties of heating and sealing openings in pressurized cabins. How formulas for predetermining the stability of planes were developed in wind tunnel tests was described by C. E. Pappas (Republic Aviation Corp.), and a summary of methods of preflight structural analyses by the Civil Aeronautics Administration and manufacturers was presented by B. L. Springer.

America At War—Communique No. 16

(*Continued from page* 107)

and notice how much more power we have in land, populations, and resources, than the enemy has—now that we have had time to catch up with the Axis' head start—you will see that it should be a matter of pride with us to throw the KO punch in the least number of rounds.

To continue: Gen. Chennault goes so far as to say that the Japs will fold a short time after the Germans do. However, most observers sincerely believe that. For, come that happy day of the Nazi fall, all the remaining great powers of the world will be wrapped around Nippon tighter than the hoops on a beer barrel.

And now, getting back to the day bombing of Germany by the AAF—that has been rather seriously misunderstood. It is largely the Army's fault, in the opinion of many Air Force people, for not giving the public the information it needs in order to see how it works. Here are the basic facts:

The Boeing B-17's and the Consolidated B-24's, which are doing the job, were initially designed as long-range bombers to defend this country—that is, to attack any hostile forces far away from our shores. Thus, these planes were built to carry comparatively small bomb loads. It is true that for a long time now we have known we would engage in the short-range air war between Germany and England. But that could not justify us in abandoning our long-range type of plane, because we could not be sure we would not yet have to use them as originally planned. There was a dark period in which it looked as if the Axis might win in Europe and head seaward against the United States.

But the design of the B-17 and the B-24, for small bomb loads, did not mean they could not lift the same loads as any other airplanes of equivalent wing area and power—operating against equi-distant targets. It did mean that, to go on the short trips against Germany, they had to be altered to carry the loads. They were so modified, and among the changes are under-wing bomb racks carrying 4,000-lb. bombs (under each wing) released by approximately the same release mechanism which is used inside.

These planes are carrying about the same loads on their high-level precision daylight attacks as the four-engined British bombers are carrying at night. And together they are jarring the life out of the enemy.

Gen. Eaker was so concerned, when misinformed writers led Americans to believe that our day bombing was "still experimental," that he took the trouble to explain the operation. He said that the RAF should continue its night work, and AAF its day attack because it is a fact that the maximum destructive effort against the enemy can be realized under these conditions only. His second point was that such attacks keep the enemy alerted 24 hr. a day, giving him no rest, and keeping several hundred thousand German workmen away from their factories and industries. And third, day operations over Germany force the Nazis to maintain a large force of day fighters which otherwise would be free to stay on the Russian or African fronts.

It has been clear for months that the German air force is not numerically capable of fighting on three fronts—Russia, Africa, and England—at the same time. It appears, at this writing,

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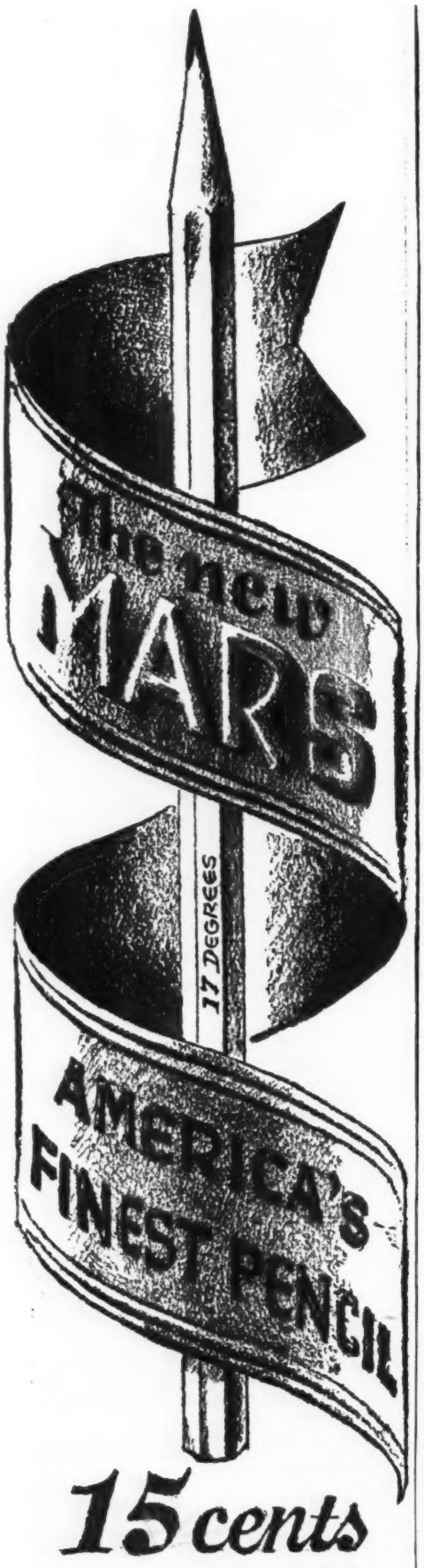

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to have given up serious efforts over England, and to have failed to hinder the Russians effectively, either by opposing their military operations or by hitting their industries. Now comes Gen. Chennault and says (to quote a China office of the Associated Press): "From evidence of various sources the enemy (Japan) has run into two bottlenecks—aircraft production and the training of airmen."

As has been pointed out before, the Japanese imported most of their machine tools. Now, to improve their airplane models in order to keep abreast of Anglo-American design, they are obliged to develop new tooling. Their technological temperament is not suited to such a task, and it has been predicted they would fall down on it.

Gen. Chennault adds that the Japs are no longer getting results in the air as they did at first; they are shunning attack in large numbers; they had offered, at the time of his statement, little effective opposition to Allied air attacks on Burma; on some of their attacks they have lost most of their planes; and their bomber crews are not as skilled as they used to be. Accordingly, the general said he thought it would not take long to smash Japan after Hitler folds up.

While both Germany and Japan grow weaker in the air, the United States grows stronger. But there is a limit. Just as the enemy reached his limit, and started to slip, and just as England has reached a maximum aircraft output beyond which it cannot go, the United States, sooner or later will hit its ceiling also. The pretty part of it is that our ceiling is a mighty high one. It looks as if the command in Washington figures around 12,000 or 15,000 a month as our limit—so long as we keep on with the current tank, ship, and gun programs.

Of course, if we should turn to a greatly augmented air war, and leave off some or most ground operations, then we would have a new aircraft production ceiling. But that probably will not happen in this war.

The same is true of aviation manpower. So long as we must supply and man ground forces, there is a limit to the forces available to operate an air force. Gen. Edwards tells Congress we will have an air force of 900 squadrons, employing 2,450,000 men, by the end of this year. The projected size of our total army is never a fixed figure, but if you call it 10,000,000, an air force of that just-mentioned size is roughly one quarter of the total army. Perhaps that is about all it can be, unless and until a new style of war is developed.

This gets us around the question of whether we actually want to build 150,000 airplanes in 1944. Nobody can answer that one, as yet, because it depends upon the needs of our allies. There are still combat zones where a lot more planes could be used right now, such as Russia and China. But as Mr. Nelson explains it, we have been filling up the "pipelines" all this time. Airplanes had to go to dozens of places, where they may never be used; reserves had to be built up before the fighting could start. The day will come, soon, when every time 100 planes are fed in at this end of the pipeline, 100 will come out of the business end at the front.

This is not to say that we are sure to find ourselves able to build all the airplanes we want for ourselves and our allies. But we might. We have built all we wanted of some other things. We have cut down orders for still others, not because we didn't want more, but because we wanted other things more. Among the latter are tanks, mobile guns, anti-aircraft guns, and trucks. We wanted airplanes more than we wanted those items, so we diverted the hours and the materials to planes.

If we find that we cannot build as many planes as we want, it will be for two main reasons. The first of them will be "change orders". They come pouring in from the front in a stream

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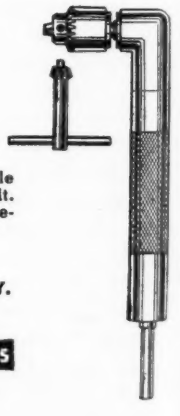

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In the photograph above, you see the aluminum "skin" that covers the wings of the Boeing B-17. To speed the output of the thirty-two-ton Fortresses, aluminum alloy sheets were needed of greater dimension than it is practical to manufacture.

On the machine pictured above, developed by Boeing tooling engineers, standard aluminum alloy stock is automatically spot-welded into "super-sheets" up to 14 feet wide and any desired length. Many times faster than flush-riveting, the Boeing automatic feed spot-welding tables make 65 controlled welds a minute, enabling Boeing to meet the extremely high U. S. Army requirements while maintaining quantity production. And the elimination of rivets reduces "drag" and increases speed in flight.

This is merely one of more than 100,000 special tools and templates developed by Boeing for the faster production of the Flying Fortress. Like many other Boeing-developed tools, it has been widely adopted by major aircraft manufacturers throughout America.

And tooling is but one of more than *twenty-five* different fields of engineering activity at Boeing . . . fields which might seem, to the uninitiated, a far cry from Flying Fortresses, Stratoliners,* globe-girdling Clippers and other Boeing-designed and Boeing-built airplanes.

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that drives the service men and the manufacturers crazy. This one thing has come pretty near upsetting some manufacturers. But the change orders are the main ingredient of advancement in design that beats the enemy, so no one wants to stop them. It all has to be managed.

Somebody has to pick out the changes that will truly improve the performance of the airplane. But he has to throw some of these selected changes away, because they would slow down production too much, doing more harm than good. It takes a lot of smart figuring to strike the right balance between quantity and quality.

The other major limit on airplane production is absentee workers. Some of the workers have no choice but to be absent, because of circumstances at home, transportation, and so on. Others must be called thoughtless and irresponsible.

The chances are that Congress is going to pass a law requiring all able-bodied men to stay on their jobs (except for good reasons) or join the Army, where they call it AWOL and the penalty is a stretch in the clink.

Britain's Ground Crews Batter Germany's War Plants

(*Continued from page* 217)

Four underslung Rolls-Royce *Merlins* of over 1,200 hp. each give the *Lancaster* its speed.

Feats of *Lancaster* aircrews in making raids far into enemy territory by day and night have thrilled the world. But without the efforts of ground crews and engineers, putting all their "know how" into insuring success, these raids would have been impossible.

Here is how Flight Sgt. Ketley of Southampton, who is the non-commissioned officer in charge of maintenance for a flight at a *Lancaster* station, describes the ground crew's work.

Last Night's Damage First

"If there has been any damage to the aircraft in sorties the night before, we get a full report on it from the flight engineer. That has to be put right first of all. It may be just a few bullet holes to be patched in the wings, or we may have to change a complete engine, which will usually take us all of 48 hr. When there's a push on, the ground crews work in 12-hr. shifts till the job is done.

"In addition, every aircraft must undergo a complete inspection every day before it is allowed to take off. We know how much depends on this, and we do make it a complete check. It takes the ground crew about 3 hr., each trade giving their own items a meticulous inspection.

"Everything that can go wrong is examined for faults. Electrical services, airframe controls, gasoline systems, radio equipment, instruments, automatic pilot, hydraulics, and guns and ammunition feeds all have to be gone over with care, and in addition the engines must have a minute and special inspection.

"Finally we run up the engines on the ground, trying out the hydraulics to flaps and turrets. It isn't till we're sure that everything is as perfect as we can make it that we hand the *Lancaster* over to the airecrew.

There is Still the Air Test

"Before a *Lancaster* takes off for an air test, in preparation for the operational trip, the airecrew go through a complete routine cockpit drill, each member checking every item of the equipment in his charge, and reporting to the first pilot that all's well, or the contrary. Even then, it is the duty of the first pilot to make his own check, for the final responsibility is his.

"Then everything is tried out in the air, with the flight engineer keeping check as on a regular flight."

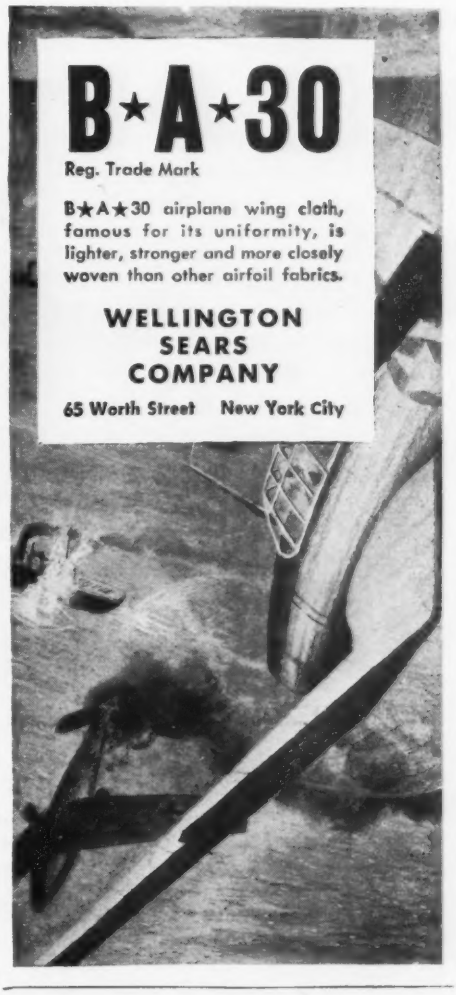
Sgt. A. Garden of Keith, Scotland, is a flight engineer who has completed eight operational trips in a *Lancaster*. He describes thus his share in keeping a *Lancaster* in the air—

"In my compartment I keep check on how all the engines are behaving. During an air test I keep a log of all the readings, and compare gasoline consumption with engine revs and the boost. Then I try out every combination of fuel systems, switching over to each tank in turn to insure that everything is in order.

"On an actual trip I still have much the same job, watching oil pressures and temperatures of coolant and engines—not that anything often goes wrong—but sometimes one gets hit by flak. As soon as I see signs of trouble, I either nurse that engine along, or if it's really bad I feather the propeller so it no longer turns over. Or if a tank is punctured by enemy fire, I switch all the engines over to it to drain it before the others."

If no one else realizes just how much depends on the engineers and ground crews, certainly the pilots do, for their lives depend on the conscientious care given to this work.

After the Milan raid one pilot said: "My kite *Leo* has been this week to Le Creusot and Milan—that's two long trips in daylight—but I never had to worry about craft or engine. Nice job from the ground lads!"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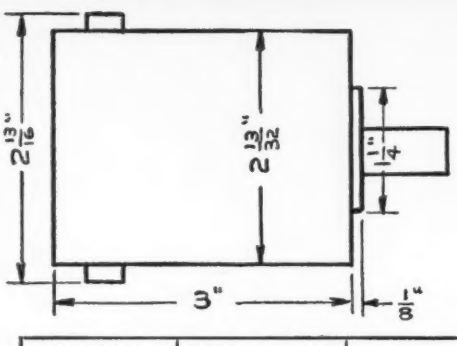

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Series	Continuous	1/50 h. p. @ 7,500 rpm
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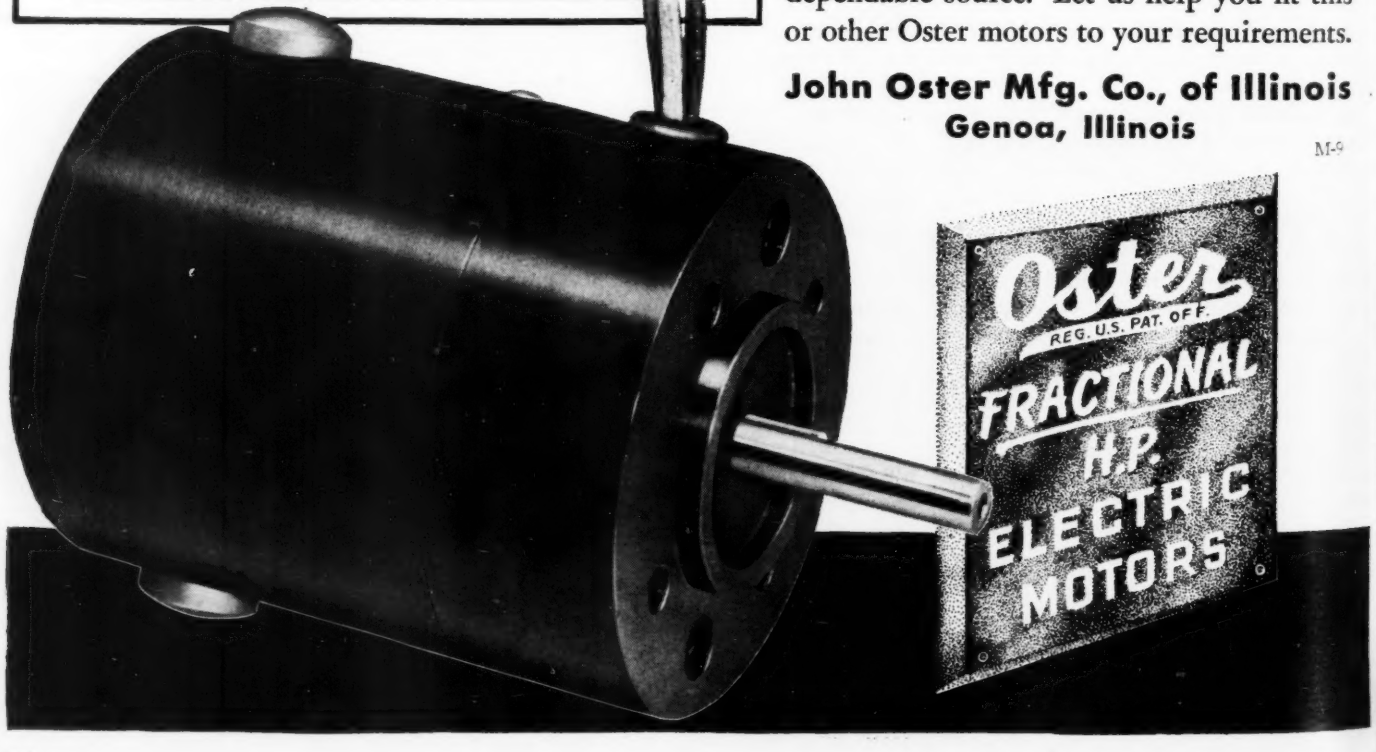

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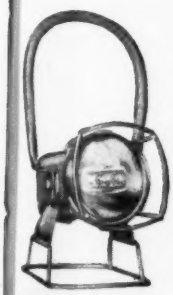

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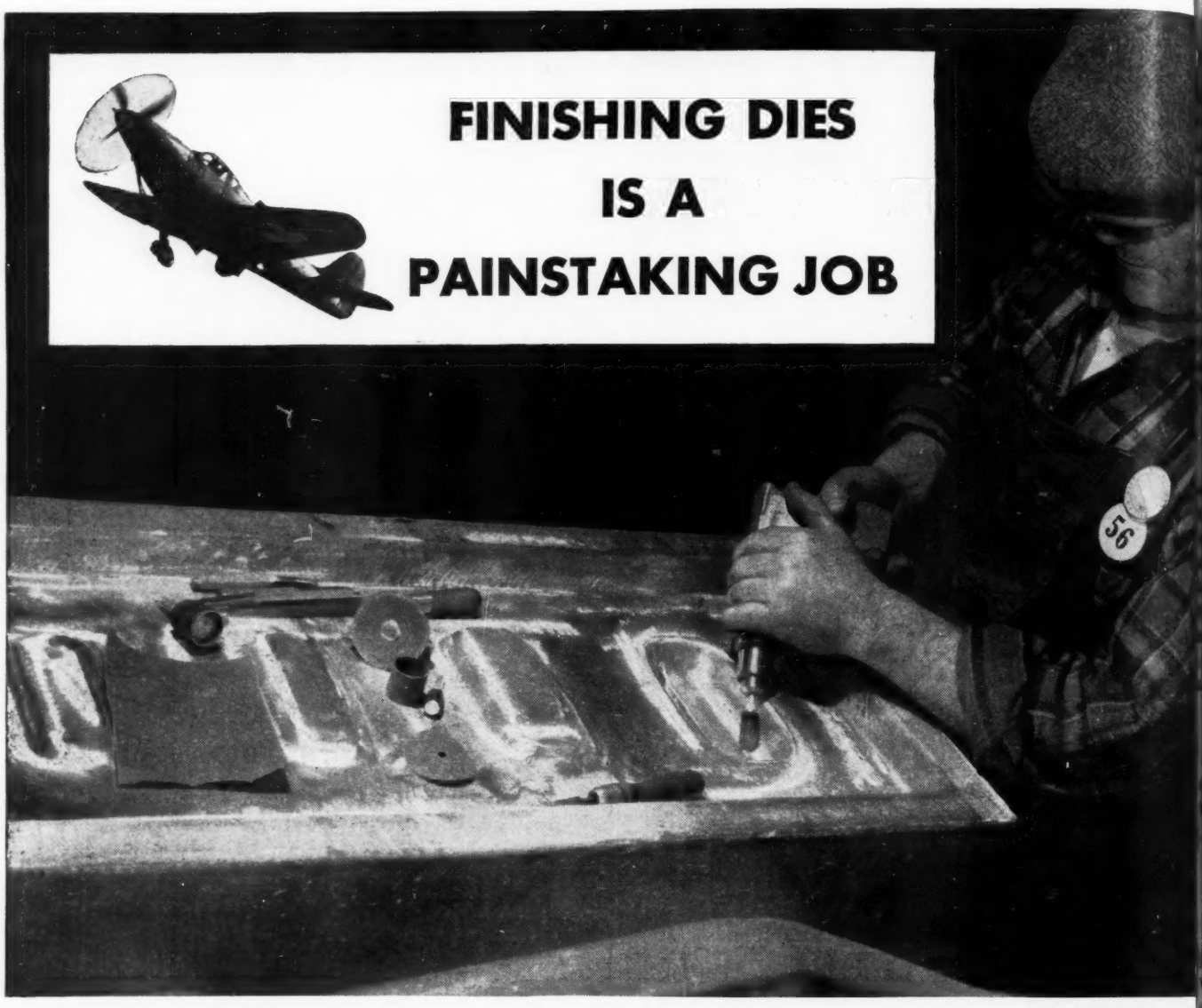

Photo Courtesy Bell Aircraft Corporation

THIS airplane worker is finishing up a die for a fuselage part for Bell Airacobra P-39 pursuit planes. It's just another instance of how Bell Aircraft is speeding production with the help of improved finishing operations.

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Points On Plastics In Aireraft Engineering

(*Continued from page* 143)

bits increase of strength as tempera- re decreases and has excellent chem- al resistance. Molding materials are ailable in granular form for com- ression as well as injection molding.

Polystyrene has been used as an in- lating foil for radio condensers and il insulation. It has been designed to coil supports for high frequency pparatus and instrument housings, sup- rts for the conductor in coaxial cables, id-proof closures, and instrument nses.

Vinyl Co-Polymer

Of the same family group which in- udes the polystyrenes, the copolymers f vinyl chloride and vinyl acetate have nusual chemical inertness and pro- uce transparent, translucent, and paque moldings. They have good elas- city at low temperature, possess tough- ss and excellent dimensional stability. pplications include control wheels nd molded gaskets.

Cellulose Acetate

Cellulose acetates possess toughness nd resiliency and are available in a remendously wide range of colors. Forms are sheets, rods, tubes, bars, molding blanks, molding powders of every description, films, packaging materials, and foils. Among the applications are numerous industrial and household molded articles, such as radio cabinets, tool handles, automotive hardware, goggles, instrument lenses, and many other injection molded applications. Other cellulose derivatives of importance are cellulose acetate-butyrate, a molding material of high impact strength, and ethyl-cellulose, a plastic similar to acetate having inertness to alkalis and dilute acids and featuring flexibility at low temperatures. Commercially, this is known as Ethocel.

Vinylidene Chloride

This new plastic is noted for high tensile strength and excellent aging properties. It is resistant to heat and most chemicals. Applications include molded parts and, in the form of extruded tubing, gasoline tubing, coolant lines, and water lines.

In Part II of this series, to appear in May Aviation, Mr. Sasso will continue with an examination of comparative properties of plastic materials.

Dynamic Balancing In Propeller Maintenance

(*Continued from page* 214)

oint falls nearer one bolt than another, isual interpolation is of sufficient accur- y to obtain the desired results. An nterpolation scale could be included on he diagram, but its complication would offset the slight added accuracy. Thus, he smallest outline indicates a total of ive 1/16-in. disks to be added, the next en, out to 20 at the outside line. If sing 1/8-in. disks, the number is of ourse halved.

It was necessary to balance a number of propellers to determine the position of each outline with respect to the center point. This diagram is applicable only to Douglas DC-3 airplanes equipped with Wright G102A engines. It also works only with gear ratios which bring the engine and propeller into phase in such a rhythm as to build up a strong vibration pattern, such as a 3/2 or a 16/9 ratio, but not a 16/11.

The latter type can be balanced with another kind of vibration indicator, like a reed, which is more sensitive. It may have to be placed on another part of the airplane to pick up the vibration, and needs its own system plotting.

Single Assembly Line Produces Bombers, Transports

(*Continued from page* 133)

ttached by means of lift-a-dot fasteners nd studs and can be easily removed.

Additional cargo space has been ained by refairing the bombardier's ompartment and replacing its glass- paneled nose with an 18-in. fuselage ex- tension and a cup-shaped cargo door. Here, too, bulkheads and floor supports are strengthened and protective panel- ing and insulating trim installed.

The Army Air Forces' need for trans- ports was so pressing that the first few C-87's off the line were practically tailor- made. There was no time to wait while jigs were built and subassemblies tooled up. The first few transports were completed practically by hand simultaneously with the job of making dies, form blocks, and jigs for the cargo doors, belly covering, and the hundreds of other changes.

But the first *Liberator Express* was more than 30 days ahead of schedule in coming off the line—a second production record for Consolidated's Texas plant. The first record was achieved last April with the turning out of the first B-24 bomber 100 days ahead of schedule—

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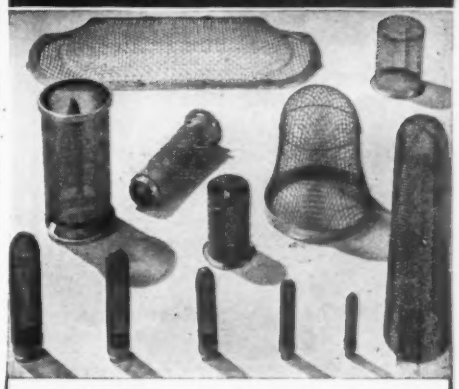

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exactly a year from the day ground was broken for construction of the first building.

Now an uninterrupted flow of bombers and transports move down the long assembly line. By not changing for the C-87, the complicated jigs in which bulkhead and stringer and piece of skin become bomber nose and tail fuselage sections, Consolidated saved months of tooling time. Once out of the jigs, the sections can become either a bomber or a transport, depending on which the AAF needs most.

Since the conversion changes are comparatively minor structural or installational variations, it has been found feasible to make them along the final assembly line. And because of the tremendous length of that line in Consolidated's plant, those changes can be broken down into hundreds of stations, permitting a division of the employees—a few to each station to make their installations unimpeded by other workmen who would have to be crowded in with a shorter line. This means less time for each ship in each station—greater production rates.

Winning the war can't wait for tomorrow. And today's cargos are moving in today's Consolidated planes.

Consolidated Celebrates Its 20th Anniversary

(*Continued from page* 125)

search and unceasing rescue work in the wake of the fighting which has restored a majority of our downed flyers to fight again—and this is 90 percent of the battle in maintaining the air service. Next comes the PB2Y *Coronado,* with a wingspread of 115 ft. and four engines, carrying cargoes and bombs to distant fronts. The B-24 *Liberator* is already famous for bombing missions and distances flown. In the form of the C-87, the *Liberator Express* has expedited loads all over the world.

To these globe trotters is added Vultee's valuable group, consisting of the BT-13, used in large numbers in our training program; the liaison ship *Sentinel,* produced by the Stinson Division of Vultee; the *Reliant,* also of Stinson; and the Vultee *Vengeance* A-31.

Early efforts of the new Consolidated management were devoted to creating an efficient, well rounded organization, skilled in every phase of aircraft construction. Today, it is centering its attention on achieving the utmost in warplane output.

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Shifting Airline Revenue and Profit Prospects

(*Continued from page* 207)

transport. Carried to an extreme, it might lead to the assertion by Congress of its undisputed power to authorize the incorporation of airlines under national law and with control of taxation.

The greatest intangible, in attempting to assess the 1943 earnings outlook, is the matter of war contracts. Government contracts—carrying military cargoes and passengers to the four corners of the earth in government-owned planes—has meant the difference between profits and deficits for some of the smaller lines.

The joint use of personnel and facilities for war work and commercial traffic has meant that the government is absorbing part of the operating overhead. This, of course, has been a factor in the recent upward trend in airline earning power. In addition, the lines have received a small fee for their war work. It is too early, though, to estimate how substantial an effect on current earnings this war work will have.

Certainly profits will be small in relation to the huge and ever-increasing volumes the airlines are flying for the government. Furthermore, the scope of the airlines' war effort extends far beyond cargo service to the training of military personnel and, in some cases, to the operation of large modification centers for making changes in combat planes before they are sent to the front.

As this is written, many of the airlines are engaged in re-negotiating their war contracts. In this connection it might be noted that airline officials are looking to the future. They are not out after large profits on war contracts, realizing full well that big earnings on war work would inevitably pave the way for cuts in passenger, mail, and express rates. Sharp reductions in these rates would leave the airlines "holding the bag" when the war is over and the present wartime traffic demand ceases.

Therefore, aside from the unknown effects of war contracts on current earning power, it would appear that airline earnings probably reached their wartime peak in 1942. But despite the probable earnings decline for some of the more prosperous companies, operations for nearly all seem likely to continue on a profitable basis for the duration.

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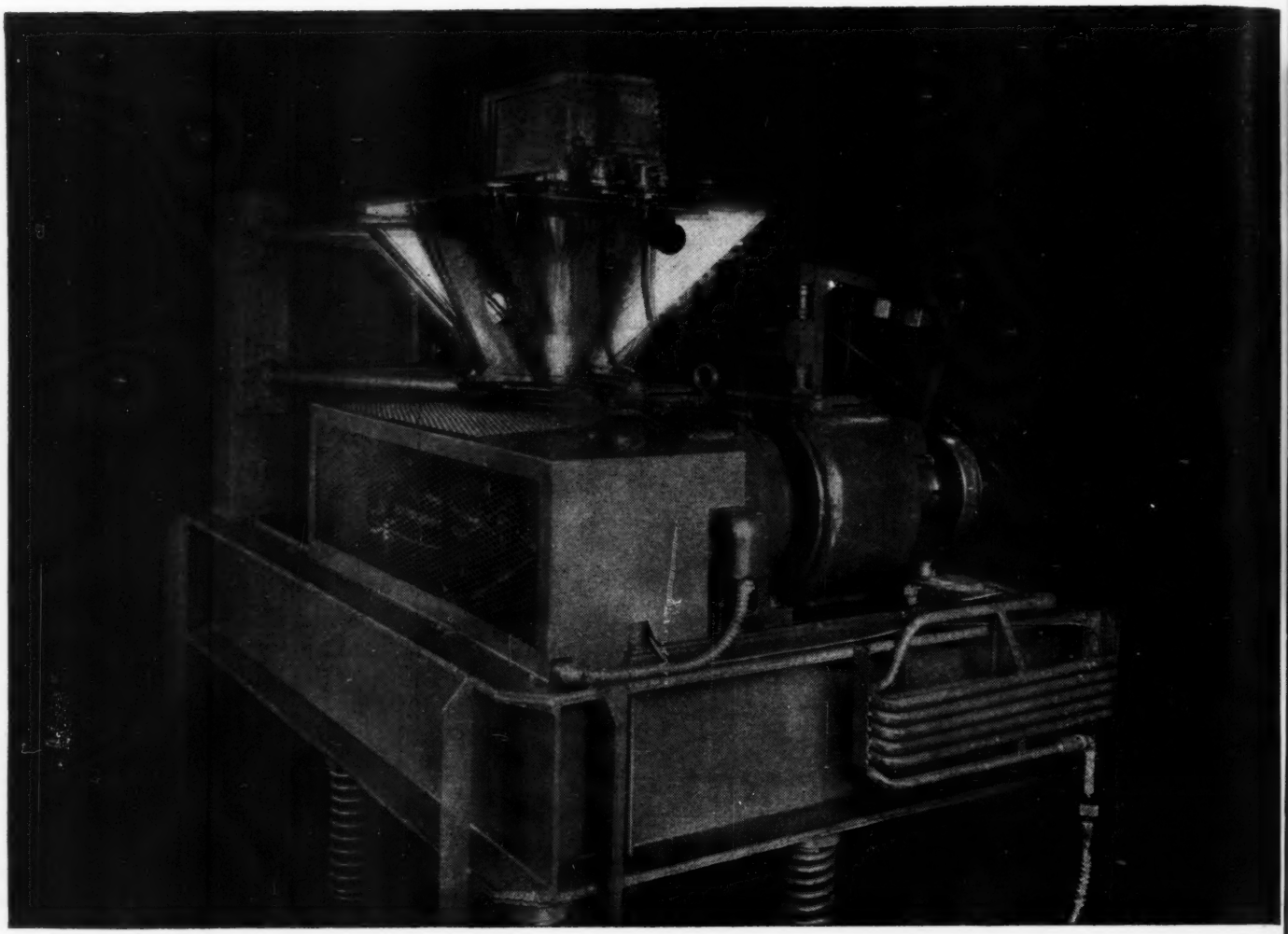

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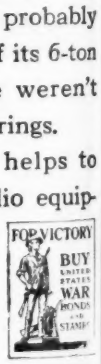

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